Weatherwise

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"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor* HENRY W. BULKLEY, *Associate Editor*

About the Future?

FORECASTING is generally considered the province of the weatherman. There is one weatherman in this country who would like some assistance in his forecasting problem. He is Dr. Francis W. Reichelderfer, Chief of the U. S. Weather Bureau. This must be an age of planning, and President Eisenhower has urged all departments of the Government to formulate blueprints for the future services that their agencies may render the American people. What role in American life do you think the Weather Bureau should play in 1965? in 1970? What will be the future demands on the weather services of the country? What trends should meteorological research take during this period? What steps should currently be taken to reach future goals? If you are concerned with the future of meteorology in America, you are urged to send your ideas to the Chief, U. S. Weather Bureau, Washington 25, D. C.

Vol. 12, No. 1 February 1959

CONTENTS

1958—A Year of Progress
— Sverre Petterssen 3

The Circulation and Weather of 1958
— William H. Klein 7

Tornadoes During 1958
— Robert G. Beebe 13

Hurricane Season of 1958
— Walter R. Davis 17

Some Noteworthy Snows of 1957–58
— David M. Ludlum 24

The Floods of 1958
— Elmer Nelson 28

Weatherwatch 30

Front Cover: Data supplied by the Office of Climatology, U. S. Weather Bureau.

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1958

A Year of Progress

SVERRE PETTERSSEN, *President, American Meteorological Society*

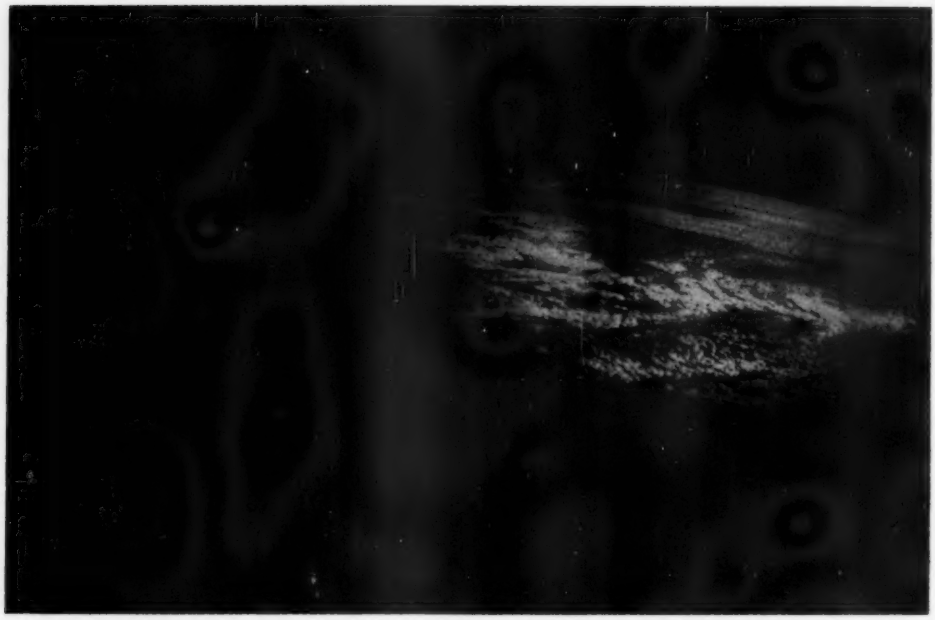
IN later year, if we review our activities, we shall probably find that 1958 was an exceptionally good year. It was good, not so much because of any particular achievement in the science and services of meteorology, but rather because meteorologists, in collaboration with men in other fields of scientific endeavor, planned well for the future.

On the whole, 1958 was a year for blueprints. All sorts of plans were made to increase our activities in meteorological research and education. The purpose has been to lift meteorology out of a state of neglect to a level of prominence in the hierarchy of the environmental sciences, and, also, to create in wider circles an awareness of the multitude of scientific problems that exist not only in the atmosphere itself but also at the interface between the earth and the atmosphere and along the tenuous border towards empty space.

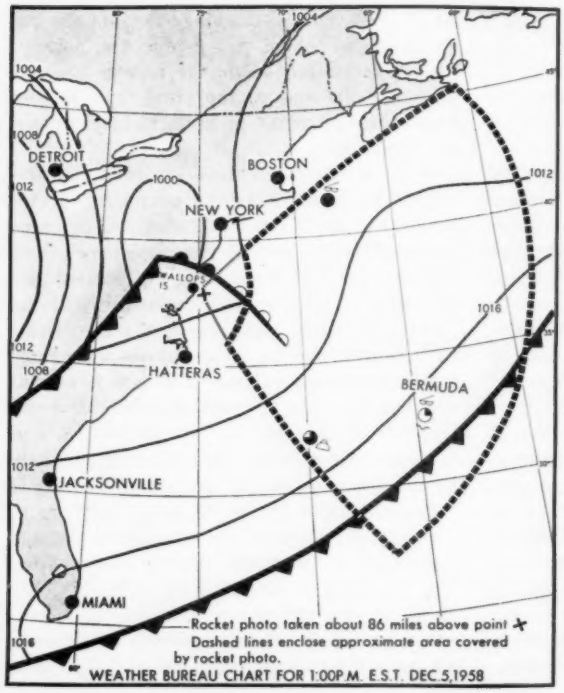
The Bulfinch House. Though blueprints usually result in buildings, the reverse process is also known. Over the last few years it became increasingly apparent that the activities of the Society had outgrown our present headquarters' size. Gradually, dreams began to form in the minds of the Officers and Councilors—dreams of a permanent home for the Society, a home with more generous space for a happy family of workers and some opportunity for growth. However, inspection of the Society's balance sheet and of commercially available office facilities seemed to pose insoluble problems and, at the same time, to present a rather depressing picture of the future of the Society. In the meantime, our headquarters staff did some really practical dreaming. In a large part, the bulk of our problems became solved when the historically famous mansion at 45 Beacon Street, Boston, Massachusetts, was given to the Society by the trustees of the Bulfinch House Trust.

During the coming year I hope we shall be able to acquaint the membership with the very interesting history of the Bulfinch House. Suffice it here to say that it was built in 1806 by the celebrated architect, Charles Bulfinch. The property was acquired in 1953 by Miss Eleanora R. Sears, noted pioneer aviatrix and Boston philanthropist, who formed the Bulfinch House Trust to ensure its preservation. As 1958 draws to an end, blueprints are being prepared which will enable the Society, within its limited means, to finance its permanent home and, at the same time, to join with others in maintaining an historic American landmark.

A Report by the National Academy of Sciences. Early in 1958 the Committee on Meterology of the National Academy of Sciences submitted its first report, with blueprints of things to come in meteorological research and education. . After a masterly analysis of the present state and future needs of meteorological research, the report continues with three major recommendations. First, it is recommended that the present support for basic research in meteorology at universities and kindred institutions be increased immediately by fifty to one hundred per cent. Second, it is recommended that a National Institute of Atmospheric Research be established through collaboration between leading universities. The Institute is intended to serve not only as an intellectual center, but also as a generous custodian of such research facilities as are required to cope with the global aspects



This illustration represents a composite of five photographs taken from a Project Hugo rocket on 5 December 1958. A frontal cloud formation is shown over the Atlantic Ocean starting offshore from Virginia about 200 miles and extending about 700 miles farther seaward. This mosaic strip covers approximately 1,000 miles in length as shown by the map below reaching from southern Maine to mid-Florida. Official U. S. Navy Photograph.



A New Look in Meteorology

The above composite photograph represents the product of the first rocket-camera unit specifically designed to photograph weather systems from high altitude. The film was recovered from a Project HUGO (Highly Unusual Geophysical Operations) which reached an altitude of 86.5 miles over the Atlantic Ocean on 5 December 1958. Project HUGO, conducted by the Office of Naval Research with funding assistance from the Bureau of Aeronautics and the U. S. Weather Bureau, is designed to further research into meteorological phenomena. The project is based at the National Aeronautics and Space Agency's Pilotless Aircraft Research Station at Wallop's Island, Virginia. The flight of the Nike-Cajun rocket was successfully tracked by aircraft and ship, and the recovery of the nose cone was made from a rough sea by the USS Leary.

of meteorological problems. Especially mentioned are large-scale electronic computors, flying laboratories, electromagnetic probing devices, rockets, satellites, etc.

The Committee stresses an important point, namely that the question of progress in meteorological research is inseparable from the problems of manpower. The third recommendation is addressed to the American Meterological Society and, in essence, it asks the Society to seek the funds necessary to develop and activate a comprehensive program with the aim of stimulating interest in meteorology ten-fold or more. In spelling out details, the Committee recommends that the Society should:

"a. Reach students through contacts with schools, through published material and publicity, through television, etc., to stimulate their interest in meteorology.

"b. Develop industrial and other non-government career opportunities which would make the field more attractive.

"c. Assist high schools and colleges in establishing general courses designed to acquaint students with the field of geophysics, in general, and of meteorology in particular.

"d. Prepare a comprehensive career bulletin on meteorology.

"e. Promote the preparation of text material in a unified series on meteorological subjects for high schools and elementary schools. Film material should be included. . . .

"f. Provide assistance to high schools and colleges, by way of printed material and films, for example, to enable teachers and others to be more effective in their guidance and counseling responsibilities."

The purpose of these undertakings should not be an attempt to attract all students into the field of meteorology, but to provide them with the opportunity to choose this field if it interests them.

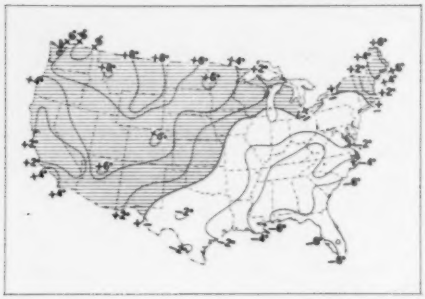
It is pleasant to observe that 1958, which started with forward-looking recommendations, ended with promising responses.

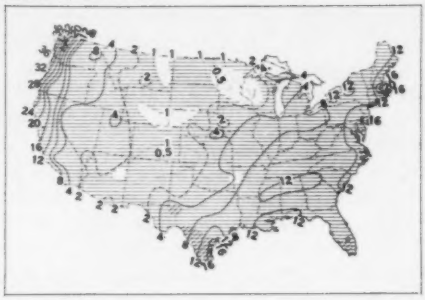
(*Continued on page 36*)

Representatives of the Bulfinch House Trust and the American Meteorological Society sign papers on 6 November 1958 transferring the Bulfinch House to the AMS. Seated, left to right: Henry De C. Ward, Treasurer, AMS, T. Temple Pond, Trustee, Bulfinch House Trust, Professor Sverre Petterssen, President, AMS, Elliott Henderson, Trustee, Bulfinch House Trust; Guy W. Walker, Jr., Treasurer, Society for the Preservation of New England Antiquities. Standing, left to right: Kenneth C. Spengler, Executive Secretary, AMS, David F. Landrigan, Attorney for the AMS; Mrs. Holt Ashley, Assistant to the Executive Secretary, AMS; Richard Johnson, Attorney, Ropes, Gray, Best, Coolidge and Rugg; John Codman, Chairman, Beacon Hill Architectural Commission; Dr. Thomas F. Malone, Secretary, AMS; Cecil H. Smith, Attorney, Ropes, Gray, Best, Coolidge and Rugg. Trustee James Lawrence, Jr. was not present at the time of the photograph. Photo by George M. Cushing, Jr.

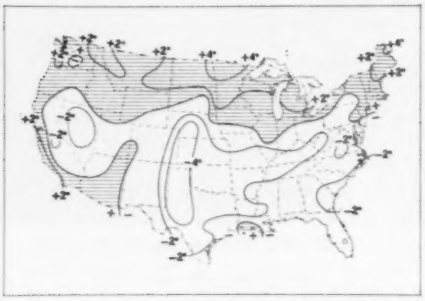
THE WEATHER BY SEASONS 1958

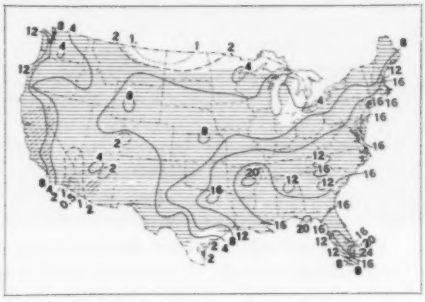
WINTER (DECEMBER–FEBRUARY) 1957–1958



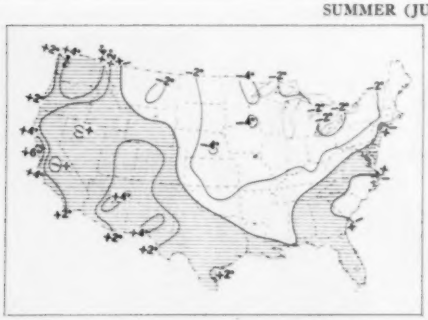


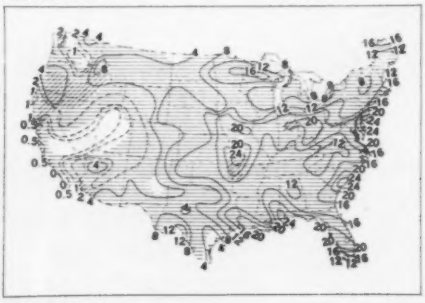
SPRING (MARCH–MAY) 1958



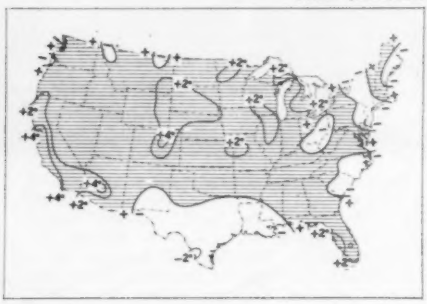


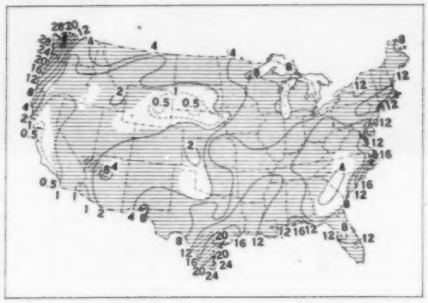
SUMMER (JUNE–AUGUST) 1958





FALL (SEPTEMBER–NOVEMBER) 1958





Charts show the departure of the temperature from normal in degrees Fahrenheit by seasons 1958. USWB charts.

Charts show the total precipitation in inches by seasons 1958. USWB charts.

The Circulation and Weather of 1958*

WILLIAM H. KLEIN, *Extended Forecast Section, U. S. Weather Bureau, Washington, D. C.*

THE GREAT INDEX CYCLE

THE general circulation underwent a striking evolution during the winter and spring of 1958, as illustrated by the wind profile shown in figure 1. The primary axis of maximum west wind or mean "700 mb jet stream" (solid arrow) was located around 45°N throughout December 1957, about 5 degrees north of its latitude on normal maps during this month (dashed curve). During January 1958 the axis of maximum westerlies shifted rapidly southward on a mean basis, reaching a minimum latitude of approximately 31°N by the end of the month, some 8° south of normal. The westerlies intensified as they moved from temperate to subtropical latitudes and attained an extreme speed of 16 meters per second just before mid-February.

The jet stream remained depressed throughout February and March, and it was not until April that it appeared as far north as 35°. The ensuing recovery was very rapid, and during May the jet axis reached a position 8° north of its normal location. Thus, from January to April the principal westerly belt remained well south of normal, and the long index cycle which began during December 1957 was not finally completed until May of 1958.

* This paper is based on the series of articles on the weather and circulation of each month appearing regularly in the *Monthly Weather Review*.

WINTER

The extreme nature of the hemispheric index cycle was reflected in corresponding abnormalities of regional circulation and weather. During the three winter months of December, January, and February the position of the planetary waves was remarkably persistent, with troughs in the eastern United States and east-central Pacific separated by a ridge over the western United States. However, the amplitude of this wave train gradually increased as the index cycle progressed. December 1957 was characterized by fast, flat westerlies and abnormal warmth in nearly all parts of the United States. Development of a strong block over Davis Strait contributed to amplification of the flow pattern during January. A succession of "northeasters" moved up the east coast from the Gulf of Mexico, releasing heavy precipitation along the entire Atlantic seaboard. Each was followed by a fresh outbreak of cold polar air, so that temperatures in the Southeast averaged 6 to 8°F. below normal for the month. On the other hand, temperatures remained above normal in New England and in the western half of the United States under the influence of

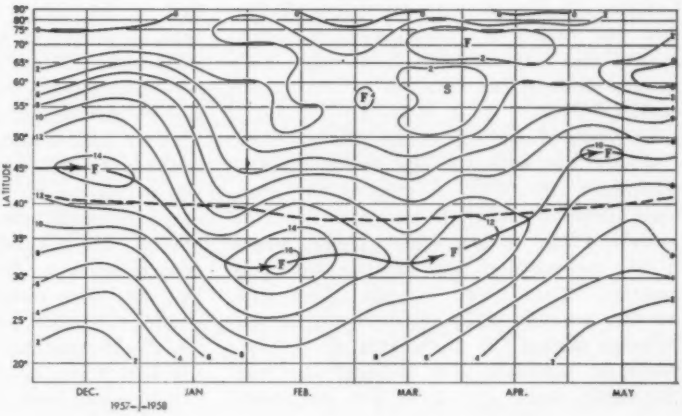


FIGURE 1. Time-latitude section of 30-day mean zonal wind speed components at 700 mb, averaged over the Western Hemisphere and computed twice-monthly in 5° latitude belts. Isotachs are in meters per second, with easterly winds negative. Centers of maximum and minimum are labeled F and S, respectively. The axis of maximum westerlies (solid arrow) was south of its normal latitude (dashed line) during the first four months of 1958.

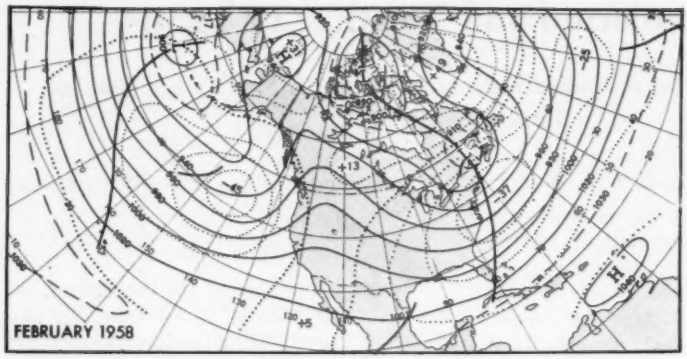


FIGURE 2. Mean 700 mb chart for February 1958. The contours (solid) are labeled in tens of feet, with intermediate contours dashed. The lines of equal 700 mb height departure from normal are dotted and drawn for every 100 ft. with anomaly centers labeled in tens of feet. The deeper than normal mean trough (delineated by heavy vertical line) along the Atlantic coast was associated with record cold and snow in the East and South.

mild maritime air masses from the Atlantic and Pacific, respectively.

During February contrasting extremes of weather and circulation reached maximum intensity. The mean circulation pattern for the month (figure 2) featured strong blocking ridges over Greenland and Alaska and the deepest mean troughs on record along the east coast of the United States and in the eastern Pacific. This was the coldest February ever observed at numerous cities in the southeast quarter of the United States and the coldest winter on record at several cities in Florida. Strong cyclonically curved northwesterly flow prevailed over the eastern half of the nation at all levels of the troposphere. In the source region for cold air, over northwestern Canada, temperatures were below normal and 700 mb heights above normal, an ideal combination to produce wintry weather in the United States. At sea level a well defined ridge of high pressure extended from a center north of Alaska through northwestern Canada and the Missouri-Mississippi Valley into the Southeast. Numerous migratory anticyclones traversed this mean ridge, each accompanied by an invasion of cold polar continental air.

Extremes of cold in the eastern half of the United States were matched by extremes of warmth in the West. Temperatures averaged above normal in the vast area from the western Plains to the Pacific Coast, where it was the warmest February on record at Seattle, Portland, and Eureka. This mild weather was the result of an intense center of below normal 700 mb heights off the Oregon coast, combined with a strong ridge over the Great Basin (fig. 2). The circulation between these two features produced a strong onshore flow from the southwest which carried warm maritime air from the southeastern Pacific into the western United States and prevented any cooling by continental air masses from the north or east.

SPRING

The stable wave pattern of the winter months changed drastically during March, as can be seen by comparing the mean 700 mb circulation for that month, figure 3, with that for February, figure 2. Much of the change can be attributed to the development of a new trough along the Asiatic coast and eastward readjustment downstream. Strong ridging in the central Pacific replaced the intense cyclonic circulation of the previous month, while a deep trough now appeared along the west coast of North America. Because of the intensity and orientation of this trough, below normal values of 700 mb height and surface temperature prevailed over the western half of the United States, where they had been above normal during February. At the same time, 700 mb heights and surface temperatures remained below normal over the eastern half of the United States, even though the east coast trough of February moved into the western Atlantic. Consequently, March was a cold month with considerable storminess and precipitation over most of the United States. These conditions can be related in general terms to the fact that March 1958 had the lowest zonal index of any month on record. Of more direct importance, perhaps, was the tremendous blocking ridge over Hudson Bay, where heights averaged as much as 710 ft. above normal (fig. 3) and high pres-

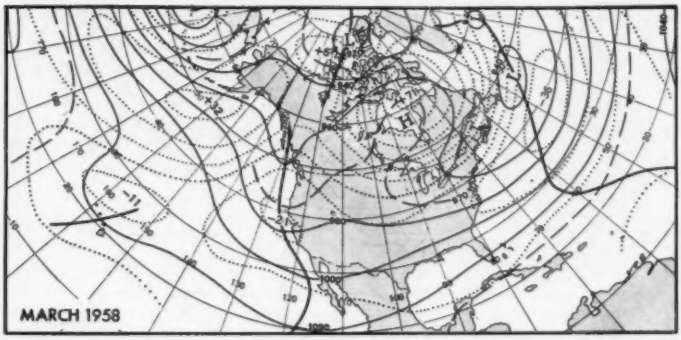


FIGURE 3. Mean 700 mb chart for March 1958. The contours (solid) are labeled in tens of feet, with intermediate contours dashed. The lines of equal 700 mb height departure from normal are dotted and drawn for every 100 ft., with anomaly centers labeled in tens of feet. Outstanding feature is the blocking high over Hudson Bay, with large positive departures from normal over Canada and negative departures in the United States.

sure persisted during each week of the month. This Hudson Bay High contributed strongly to southward displacement of the jet stream and cyclone tracks and resulting cold, stormy weather in the United States.

The general circulation during April represented a transition stage over North America from a low index state to one of a higher index. Weakening of the block over Hudson Bay and entry of the west coast trough into the central United States were responsible for considerable variability in weather and circulation patterns from week to week. As a consequence, the monthly mean pattern was rather flat with weak gradients and small height and temperature departures from normal. Weak westerly flow over the United States and remnants of Canadian blocking permitted a short wave spacing, so that three separate troughs appeared on the monthly mean chart. Since each was associated with widespread precipitation, April was a wet month in most of the United States.

May was the first month of 1958 in which the mean 700 mb jet stream was north of normal and the monthly zonal index higher than normal. During April the jet axis had been centered near the Gulf of Mexico, but in May it was over the Great Lakes. This abrupt northward displacement was associated with the appearance of a deep cyclonic vortex on the monthly mean map (figure 4) over Hudson Bay, where blocking and above normal heights had prevailed during the previous two months (fig. 3). At the same time a strong ridge reappeared over the western United States (fig. 4), resulting in pronounced warming west of the Mississippi. Greatest change occurred in the Rocky Mountain area, where anomalous temperatures rose as much as 9°F from April to May (figure 5).

The mean circulation and thermal patterns observed during May were unfavorable for precipitation in the United States. From the Great Lakes westward to Montana monthly totals averaged only about half of normal. Parts of this area had been deficient in precipitation since the first of the year, this being the driest January to May period since 1871 at Detroit and the second driest at Minneapolis. Another consequence of this month's high index and ridge-trough struc-

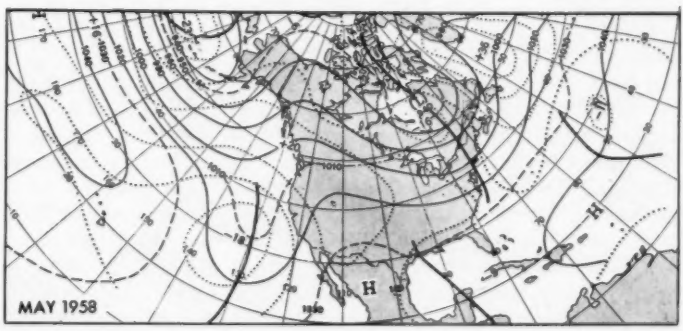


FIGURE 4. Mean 700 mb chart for May 1958. The contours (solid) are labeled in tens of feet, with intermediate contours dashed. The lines of equal 700 mb height departure from normal are drawn for every 100 ft., with anomaly centers labeled in tens of feet. Principal features in North America are stronger than normal ridge in the West and deeper than normal trough (heavy vertical line) in the East.

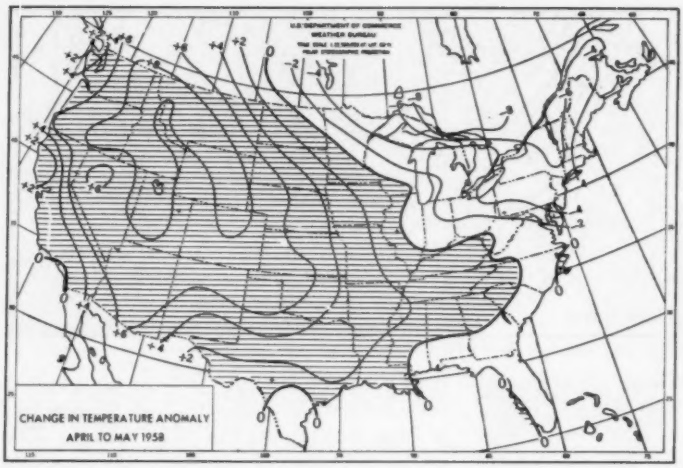


FIGURE 5. Change in departure from normal of monthly mean surface temperature (in degrees F.) from April to May 1958. Note pronounced warming throughout most of the West and cooling in the Northeast.

ture in the United States was a 60 percent reduction in the frequency of tornadoes from May 1957 to May 1958. This reduction can be attributed to increased flow of dry air from the northwest, northward displacement of the jet stream, and reversal of the temperature gradient.

SUMMER

June 1958 was characterized by slightly above normal speed of the mid-latitude westerlies at 700 mb in the western hemisphere and, in this sense, was a continuation of the state achieved during May. However, in June the maximum west wind belt receded southward from the high latitude of 47°N reached during May, as can be seen by comparing the solid with the dashed curves in figure 6. The southward migration of the maximum westerlies was accompanied by general cooling, relative to normal, over most of the country, and many cities from the Mississippi Valley eastward reported their coldest June of record. By way of contrast, this June was the warmest on record at many places in the Pacific Northwest, and temperatures remained above normal in much of the Southwest.

The mean circulation pattern for June resembled that for May (fig. 5), with a deeper than normal trough extending from Hudson Bay to the Middle Atlantic coast, a stronger than normal ridge in western Canada, and a deeper than normal trough off California. However, the ridge in the western United States flattened considerably during June as a strong zone of confluence became established in the central part of the country. Figure 6 portrays this confluence between the southern branch of the jet stream, carry-

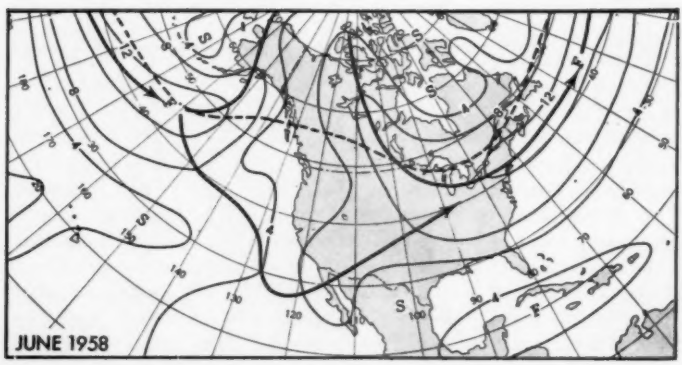


FIGURE 6. Average 700 mb wind speed (in meters per second) for June 1958, with centers of fast and slow speed labeled F and S, respectively. Solid arrows indicate axes of maximum wind speed (jets), while dashed curve shows position of principal jet stream in May 1958. Confluence of two jet axes near lower Great Lakes was responsible for severe weather in Mid-West.

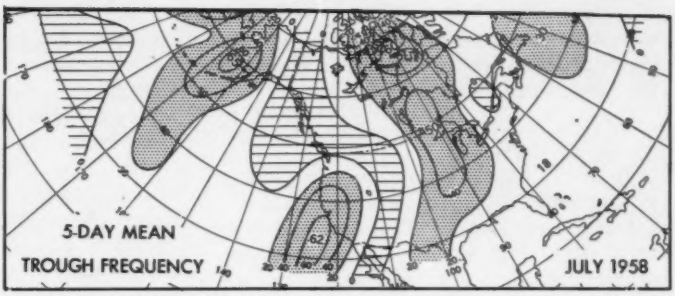


FIGURE 7. Percent of the time that troughs on 5-day mean 700 mb charts were located within 10° longitude intervals from 30 to 70°N during July 1958. The lines of equal frequency are drawn at intervals of 20 percent, with frequencies greater than 20 percent stippled and zero areas hatched. Unusually high frequency of troughs in central United States caused cool, wet weather.

ing warm air from Arizona to the Ohio Valley, and the northern branch, carrying cold air from the Arctic Ocean to the Great Lakes. The confluence resulted in sharp frontal and cyclonic activity with abundant precipitation in many parts of the country. Floods in Indiana, tornadoes in Wisconsin and Kansas, squalls and severe thunderstorms in the East, and record-breaking rain in the northern Plateau were some of the highlights.

The outstanding feature of the monthly mean circulation pattern at 700 mb for July was a wave of large amplitude extending from the central Pacific to central North America. Vorticity flux from a deep trough in mid-Pacific and a strong ridge just off the coast of British Columbia was strong and persistent enough to produce cyclonic flow with below normal heights over most of the central United States, in spite of the thermal factors which normally support anticyclonic conditions aloft in this area during summer. As a result, troughs were located over the Mississippi Valley on almost half the 5-day mean maps during this July, as shown by figure 7, in a region where they are normally quite rare. Equally anomalous were the high trough frequencies in the central Pacific and western Atlantic. Thus the mean circulation of July 1958 was of a type seldom observed in mid-summer.

Abnormalities of the July circulation produced corresponding abnormalities of the weather. Stronger than normal northerly flow over western North America resulted in numerous invasions of cool air masses over the central United States. Since the cool air repeatedly penetrated unusually far south, an active frontal zone was frequently located at rather low latitudes for July along an east-west band from the Middle Atlantic States to the Southern Rocky Mountain States. A strong jet stream in a zone of marked confluence existed above the frontal zone. Because of these factors, as well as its abnormal cyclonic circulation, July was a wet month over most of the United States, with some regions reporting 3 to 5 times the usual rainfall. In central areas and in the Northeast extreme amounts from 5 to 15 inches established many new station records.

During August the mean circulation over the United States returned to a pattern more typical of summer, with troughs along the east and west coasts and a strong ridge over the Rockies. This resulted in a marked reversal from the July temperature regime, with cooling in the East and warming in the West. The departure from normal of monthly mean temperature rose by more than 9 degrees from July to August in portions of Montana and Nevada, and record warmth for August and for the entire summer was reported from several locations in Washington, Oregon, and California.

The July pattern of heavy rains and flooding through the Ohio Valley and Central Plains continued to dominate early August. Thereafter these excessive rains terminated as a ridge moved into the Midwest and brought warm drying winds to the area. Frequent frontal activity during the month released heavy rainfall in a band extending from Texas northeastward to the Middle Atlantic States. Shower activity was widespread in the Southwest, and rainfall exceeded twice the normal over large parts of California, Nevada, and Oregon. This precipitation resulted from a moist tongue which curved anticyclonically around an upper level high in Arizona and transported Gulf moisture across Mexico in a broad southeasterly cur-

rent. The Northwest remained hot and tinder-dry for the entire month under the influence of the western ridge, and a serious forest fire hazard developed.

FALL

The mean circulation for September was characterized by high index from the coast of Asia eastward to the British Isles. This fast westerly flow resulted in rapidly changing circulation and weather regimes, so that the departures from normal of monthly mean 700 mb height and surface temperature were quite small in most areas of the United States. Precipitation for the month averaged considerably above normal in the southern half of the country west of the Appalachians, and flooding occurred in the Rio Grande Valley. Cyclonically curved anomalous flow from the south favored advection of Gulf moisture, and rainfall was released in convergence zones associated with fronts, weak tropical depressions, and orographic lifting. Four tropical storms formed in the vicinity of the Antilles this September near a mean easterly jet. Three of these storms moved northward in a broad trough and southerly anomalous flow off the east coast of the United States, with one, Hurricane Helene, grazing the coast of the Carolinas.

Fine fall weather prevailed over most of the United States during October with few extremes observed. Temperatures averaged below normal east and south of a line from New Mexico to New York and above normal west and north of this line. The unseasonable warmth throughout the West was associated with a stronger than normal upper level ridge with 700 mb heights 140 ft. above normal (figure 8). Greatest temperature departures were observed in California and Arizona, where several cities established new monthly temperature records. The cool weather in the southeastern quadrant of the nation was related to northerly anomalous flow to the rear of a deeper than normal mean trough near the Atlantic Coast. Above normal temperatures in northern sections were caused by flow from an abnormally warm source region in central Canada, where a blocking ridge prevailed (figure 8).

October was a dry month over much of the United States, with most of the area from the Appalachians to the Pacific receiving substantially less than normal precipitation. At Salt Lake City only 14 per cent of the normal amount fell from May to October 1958. This dry weather was associated with stronger than normal northwesterly flow which prevented penetration of moisture into the country.

November was the seventh consecutive month of above normal zonal index. This extended period of fast westerlies may have been some sort of compensation for the extremely low index values which prevailed during the first four months of 1958. As a result of the high index circulation the United States was dominated by mild Pacific air masses during November, and almost the entire nation averaged above normal in temperature. However, departures from normal of both surface temperature and 700 mb height were rather small because of a marked reversal which occurred during the month. The first half had a continuation of the October

(*Continued on page 38*)

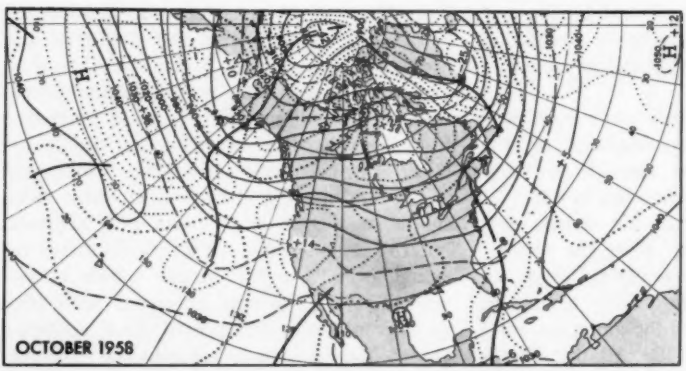


FIGURE 8. Mean 700 mb chart for October 1958. The contours (solid) are labeled in tens of feet, with intermediate contours dashed. The lines of equal 700 mb height departure from normal are dotted and drawn for every 50 ft., with anomaly centers labeled in tens of feet. Note recurrence of stronger than normal ridge in the western United States, deeper than normal trough in the East, and blocking over Canada.

The funnel of the Washington County, Minnesota, tornado on 24 May 1958 as photographed by Charles A. Barnes of Eau Claire, Wisconsin. Of particular interest is the "mother vortex" formation of the cloud above the funnel.

Tornadoes During 1958

ROBERT G. BEEBE, *Midwest Weather Service, Kansas City, Missouri*

TORNADO occurrences during 1958 took a sharp downward drop as only about 624 were reported this past year. This is substantially less than the 851 reported during 1957 or for any year since 1953. However, climatological figures on tornado occurrences continue to be something less than dependable because of changing methods of compiling statistics and the manner of reporting. The number of tornadoes reported in each state is shown on the accompanying map and it may be noted that only Nevada, New Hampshire, Oregon, Utah, Vermont, and West Virginia were favored by non-tornadic winds during 1958. The spring season was unusually quiet, but in June 157 tornadoes were reported and this was the second greatest of record, being topped only by 164 in 1957.

Along with the lesser number of tornadoes during this past year, the number of lives lost was sharply lower with only 59 fatalities as

compared with an average of over 200 for the past 43 years. These deaths were caused by 10 tornadic situations, and three of these accounted for the loss of 50 lives.

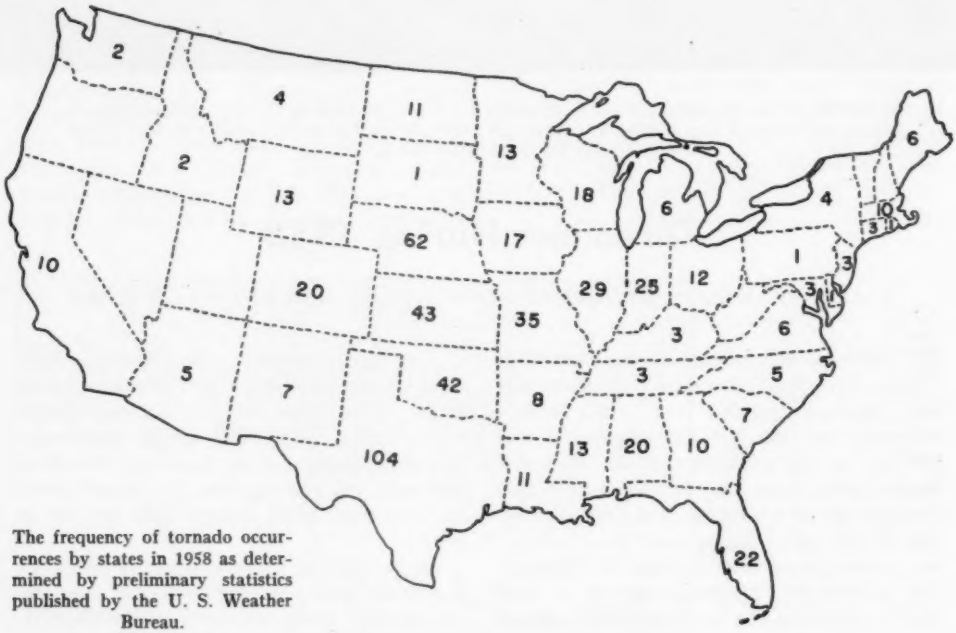
The first death-dealing tornado situation of 1958 moved across the Southern states on 26 February. This storm setting spawned the first tornado in eastern Oklahoma at 1400 CST. Tornadic winds continued to develop during the afternoon and evening over Arkansas, Louisiana, Mississippi, Alabama, and Tennessee. Altogether, 17 funnels were reported, 8 lives were lost, nearly a hundred persons were injured and property damage amounted to over a million dollars.

The most devastating tornado outbreak of the year began at 1620 CST on 4 June in eastern Minnesota. By 1930 a dozen funnels had snuffed out the lives of 27 people, injured nearly 200 others, and laid waste to property and crops totaling $10 million. The most destructive of these tornadoes occurred in St. Croix and Dunn counties where the tornado was reported to have had a forward speed of 52 mph.

Six days later, on 10 June, another family-type outbreak developed during the afternoon over eastern Kansas and western Missouri. During this outbreak, 14 tornadoes and funnels were reported between 1420 and 2100 CST. The most destructive of these tornadoes of this series formed seven miles northwest of El Dorado, Kansas at 1730. The funnel moved towards the southeast and devastated the southwest section of town at 1745. Here, in less than three minutes, 15 persons were killed, 50 others injured, and property damage amounted to $3 million. In lives lost, this tornado ranks as the third worst in Kansas history. The only other tornadoes which resulted in more deaths were those at Udall in 1955 and at Prescott in 1887. Just prior to the formation of this tornado, the thermometer of the Gas Service Company had recorded a temperature of 100 degrees, but the mercury dropped 20 degrees in 15 minutes with the passage of the tornado.

One of the most unusual outbreaks of the year was an unseasonal development on 17 November. These storms were reported as early as 0600 CST near Abiline, Texas, and as the storm setting progressed northeastward, some 40 tornadoes were reported over Texas, Oklahoma, Arkansas, Kansas, Missouri, and Iowa before midnight.

As is often the case in studying reports of

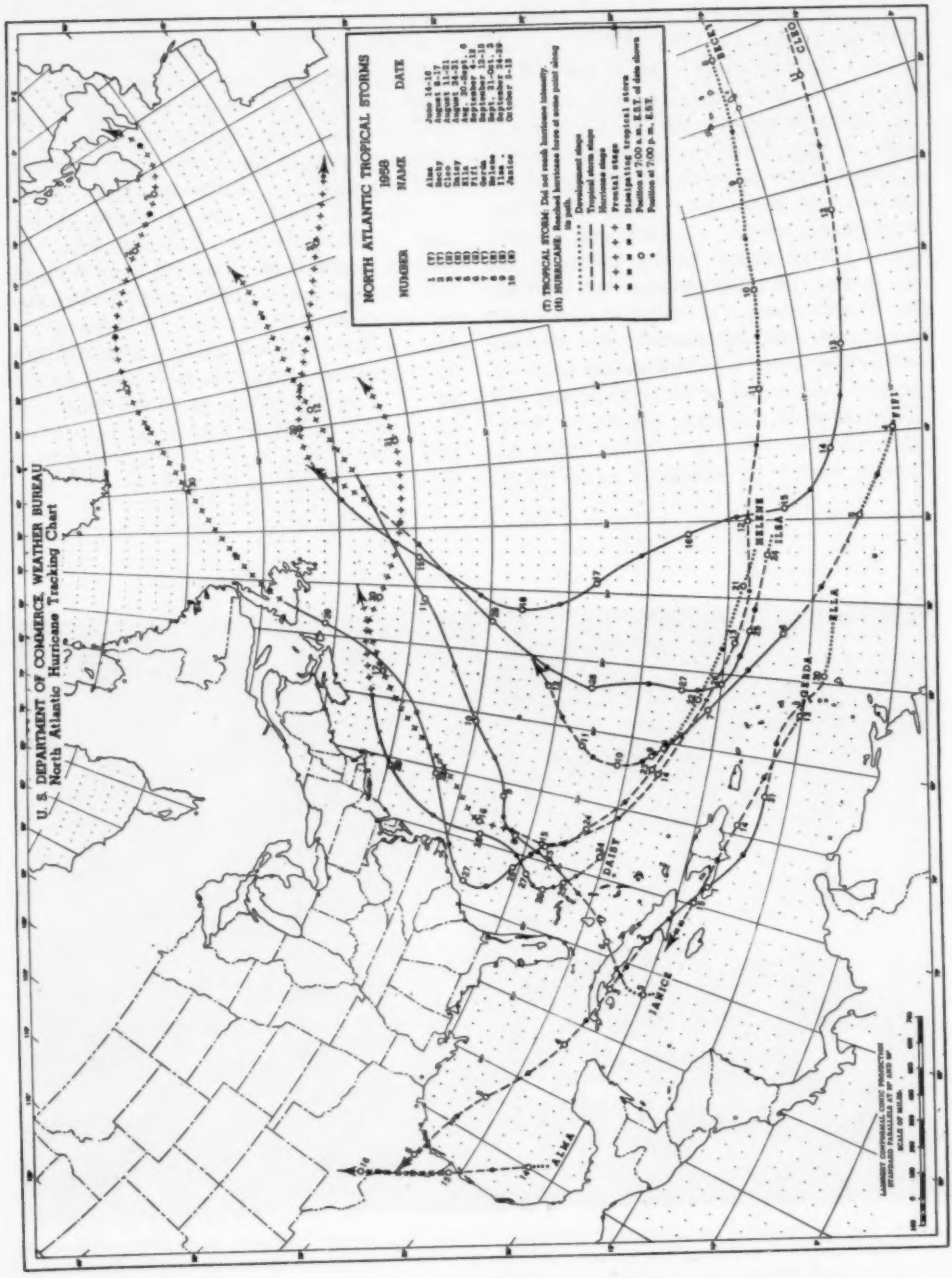


The frequency of tornado occurrences by states in 1958 as determined by preliminary statistics published by the U. S. Weather Bureau.

tornado occurrences and damage, a number of unusual incidents occurred during 1958. Alaska became a state this past year, and the event is marked with a tornado being reported at Fairbanks at 1415 CST on 16 May. Although the storm was of small size and intensity it is noteworthy because very few such storms develop in Alaska. California is usually a state quite secure from tornadoes, but the past year included 10 tornadoes there, with the first in January and with an unprecedented tornadic activity in March. Florida ranked eighth in the nation in the total number of tornadoes reported with 22. The Florida storms on 15 April were the most intensive and destructive, property damage totaling nearly a million dollars from the complete destruction of some 40 homes and damage to over 200 other buildings. Rensselaer, Indiana, had the unusual distinction of being visited by tornadoes twice during the same day on 8 June. In South Dakota, where a number of tornadoes are expected every summer, only one was reported during the entire year.

A survey of the Climatological Data, National Summaries, reveals other interesting items occurring in connection with severe local storms. For example, on 9 July two planes engaged in cloud seeding in Colorado were damaged by hailstones while flying through hail clouds. On 20 August at Topeka, a vivid flash of ball lightning, described as about the size of a large dishpan and running along a fence, ended with a violent explosion at 2130 CST. In Maine on 28 June, a dust devil was credited with lifting a 300-pound swing as much as 70 feet into the air. During the afternoon of 15 June near Lineville, Missouri, a tornado is reported to have lifted a horse into the air and deposited the animal on the ground unhurt.

A rope-like funnel as seen from the main street of Pondcreek, Oklahoma, on 22 April 1958. Gene Wilson caught this shot of the funnel just before it lifted from the ground. The tornado moved across north-central Oklahoma close to the Kansas border, but apparently did very little damage. Wide World Photos.


U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
North Atlantic Hurricane Tracking Chart
NORTH ATLANTIC TROPICAL STORMS
1958
NUMBER
NAME
DATE
(T) TROPICAL STORM: Did not reach hurricane intensity
(H) HURRICANE: Reached hurricane force at some point along its path
Development stage
Tropical storm stage
Hurricane stage
Frontal stage
Dissipating tropical storm
Position at 7:00 a.m. EST of date shown
Position at 7:00 p.m. EST
ALMA
DAISY
JANICE
ELLA
HELENE
FIFI
CLEO
DICEY

Hurricane Season of 1958

WALTER R. DAVIS, *U. S. Weather Bureau, Miami*

THE hurricane season of 1958 in the Gulf of Mexico, the Caribbean Sea, and the Atlantic Ocean produced a total of 10 tropical storms, seven of which reached full hurricane intensity. The season could be considered about normal, as far as the number of storms is concerned. During the past 40 years an average of nine storms per year has occurred, while during the past 75 years the average is eight storms.

Four tropical storms affected the United States mainland during the hurricane season of 1958. Tropical storms Alma and Ella passed into Texas and Hurricanes Daisy and Helene skirted along near and off the coasts of the Atlantic states. Storms Alma and Ella caused some damage in Texas due to floods after abnormally heavy rains. Daisy did negligible damage while skirting the North Carolina and New England coasts. Hurricane Helene was the only storm that produced hurricane winds on the United States mainland, causing in excess of $11 million damage in the Carolinas. One life was lost as a direct result of Ella, when a shrimp trawler was sunk on the Galveston Jetty. Another casualty resulted indirectly from Hurricane Helene in North Carolina.

Tropical storm activity was concentrated in the Atlantic this season, with recurvature to the north and northeast before passing inland over the Atlantic states. This was in contrast to the majority of the storm activity in the Gulf of Mexico in 1957. The westerlies were depressed south of their normal track during most of August and also at times in September. The upper-level trough at 700 and 500 mbs oscillated back and forth from the Mississippi Valley to some 800–1,000 miles off the Atlantic coast with the mean trough lying near the east coast. The subtropical high over the Atlantic was fairly well developed during most of the hurricane season; however, this seemed to break at the opportune time as strong waves in the westerlies passed across the northern United States into the North Atlantic, to allow the tropical storms to recurve northward and northeastward far at sea or near the coast as in the case of Becky, Daisy, and Helene. Ella and Gerda were the only tropical storms of the season to form and remain in the deep easterlies during their entire life histories.

About the middle of October a complete reversal of the planetary trough-ridge systems over the Northern Hemisphere occurred and has been described by J. F. Andrews. This change resulted in a split jet with the southern branch becoming located over Florida flooding that area with polar air. Tropical cyclone development, which had been quite active since early in August, abruptly terminated.

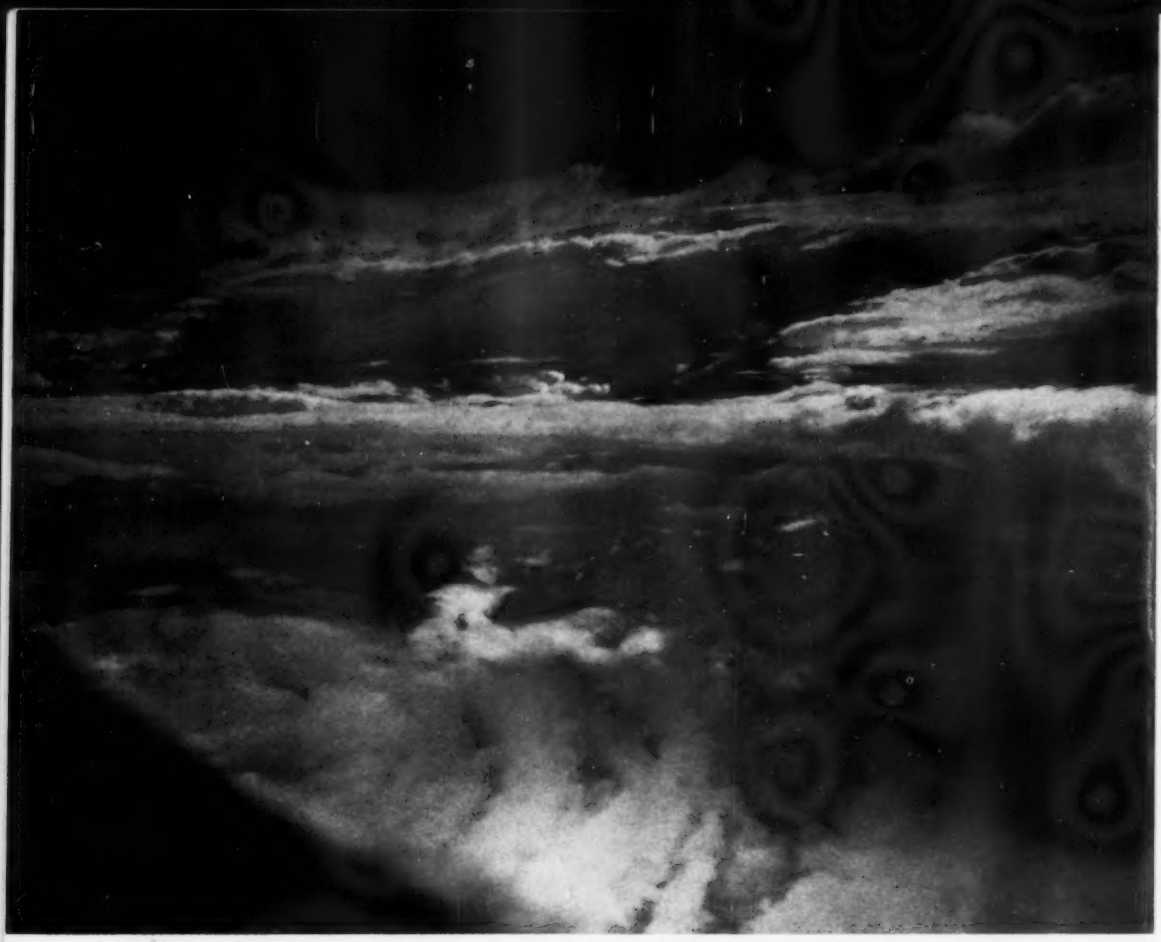
The following is a summary of the individual tropical storms and hurricanes of 1958:

1. TROPICAL STORM ALMA, 14–15 JUNE

Tropical Storm Alma developed in an easterly wave in the central Caribbean that was detected as early as the 9th and 10th of June. Considerable shower activity was occurring on these dates over the central and western Caribbean and northward across Cuba into the Bahamas. On the 10th a weak closed circulation appeared near Latitude 15N, Longitude 78W. This area drifted slowly west and northwest into Central America and on the 13th a weak circulation was evident in the Gulf of Campeche in the southwest Gulf of Mexico. The disturbance moved northwest along and off the Mexican coast and developed into a tropical storm about midday of the 14th some 150 miles off Tampico. It passed inland a short distance south of Brownsville, Texas, on the 15th.

Highest winds reported were 45 to 50 mph from the *MV Mada* on the 14th, 50 knots from a Coast Guard aircraft 50 miles south of Port Isabel, Texas, at 0800, and 40 to 45 mph at south Padre Island, Texas, at 1000 on June 15th. Heavy rains occurred over the hill country to the west of San Antonio, generally averaging 7 to 10 inches with amounts as high as 20 inches near and west of Medina.

Damage from winds and tides associated with this storm was slight, but considerable



The eye and wall cloud of Hurricane Cleo on 18 August 1958 as seen from a TB-50 of the U. S. Air Force on a special flight for the National Hurricane Research Project. The photograph, taken at a 15,500-ft altitude, shows the well-formed eye with some lower cloudiness, but the eye above 12,000 ft was essentially clear. The wall was completely closed and rose to about 36,000 ft. Maximum winds in the wall were about 90 mph. Photo courtesy of the National Hurricane Research Project, U. S. Weather Bureau.

losses resulted to crops and property due to the heavy rains and floods. One death by drowning occurred in the Galveston area during the passage of the storm.

2. TROPICAL STORM BECKY, 11–15 AUGUST

The second tropical storm of the season was positively identified on August 11th about midway between Puerto Rico and the Cape Verde Islands by receipt of a series of reports from the *SS Industrious*, near Latitude 18N, Longitude 45W.

Reports from the Cape Verde Islands on the 7th and 8th indicated the passage of a tropical depression through that area. It continued westward and on the 12th, reconnaissance aircraft found a complete cyclonic circulation at 700 mbs with maximum winds of 60 knots at flight level and minimum sea level pressure of 1,006 mbs, or 29.71 inches, which was obtained by dropsonde. Becky continued on a west to west-northwest track and passed about 290 miles northeast of Puerto Rico on the 13–14th. The storm then began a gradual recurve to the northwest and north around the western periphery of the Bermuda high pressure area, then turned toward the northeast on the 16th.

The lowest pressure reported was 1,006 mbs, or 29.71 inches. The storm increased in size with time, though the area of gale winds remained mostly in the north and east semicircles around the center. Maximum winds were generally 55–60 knots, but winds of 75 knots were reported in squalls some 200 miles northeast of the center on the 14th.

The sub-tropical high pressure cell to the north of Storm Becky was well established throughout its life, generally about 1,023 mbs, which is about normal for the month of August. Becky moved rather rapidly throughout its track averaging about 20 knots. We believe that movement of 20 mph or more is not favorable for intensification, this being an old empirical forecasting rule of long standing.

3. HURRICANE CLEO, 11–21 August

A fairly well developed easterly wave passed through the Cape Verde Islands on August 11th. Sparse reports to the west and northwest of this area on the 12th and 13th indicated a large cyclonic circulation was developing. No reports were close enough to give an accurate location or to indicate the intensity of a tropical storm.

On the 14th, reconnaissance aircraft located Hurricane Cleo at Latitude 14.7N, Longitude 47.1W. The aircraft located a very intense storm with maximum winds estimated 146 mph and lowest pressure 962 mbs, or 28.41 inches. On the basis of sparse data, the storm was estimated to have been moving at about 21 mph from the 11th to the 13th. On the 14th the storm began decelerating and turning northward, being influenced by an upper trough near Longitude 50W. It continued on a north to northwest course until picked up by a short wave trough on the 19th, recurved to the northeast and accelerated to near 30 mph. It began to fill and lose tropical characteristics north of the Azores on the 21st.

Based on minimum pressure of 947 mbs, or 27.96 inches, the storm did not reach maximum intensity until the 15th. Winds of 146 mph were reported on the first day of penetration, but were not encountered this strong again. The aircraft probably did not find the area of maximum winds on the 15th.

Hurricane Cleo was an extremely severe storm and no reports of severe damage to shipping or loss of life were reported despite its passage through the principal transatlantic shipping lanes.

4. HURRICANE DAISY, 24–31 August

Hurricane Daisy formed in a strong easterly wave which passed through the Lesser Antilles 20–21 August. There was little indication of intensification until the 23rd when the wave was moving through the Windward Passage. A vortex developed on the 24th and reconnaissance aircraft located an eye just north of the central Bahamas with maximum winds of about 55 mph and a central pressure of 1,002 mbs or 29.59 inches.

Hurricane Daisy moved very slowly north-northwestward on the 25th and the forenoon of the 26th. The storm recurved on the 26th near Latitude 28N, accelerated in forward speed and continued on a north to north-northeast course passing about 75 miles east of Cape Hatteras on the 28th moving about 20 mph. The following morning it passed about 70 miles southeast of Nantucket, Mass., moving east-northeast about 25 mph on a second recurve. The strongest wind at Cape Hatteras was 27 mph from the north-northwest, with gusts to 36. Block Island reported 40 mph with gusts to 45. A Texas Tower, 120 miles east of Cape Cod, experienced a sustained wind of 69 mph with gusts to 87. There was no loss of life or appreciable property damage in the United States from Daisy.

At the time Daisy formed, the westerlies over the United States were far south of their normal position for the second half of August. On the 24th at 500 mbs, westerly winds extended southward into the Gulf of Mexico. A similar pattern had prevailed during most of the month, a circulation feature which steered Daisy away from the coastal areas of the United States. While the hurricane was forming, the 500 mb subtropical ridge over the western Atlantic was north of Bermuda. During the first two days of Daisy's history, a weak extension of this ridge separated the hurricane from the westerly flow just to the north. While the storm was small and relatively weak, it was unable to break through this ridge, which partly explains the very slow movement prior to the first recurvature. Deepening of the storm took place simultaneously with the passage of a strong short wave trough through the central portion of

the United States. The intensification of the storm increased the internal forces which tend to drive a hurricane northward at the same time that the approach of the short wave weakened the feeble ridge north of Daisy. This combination permitted the subsequent rapid northward progress of the storm.

5. HURRICANE ELLA
30 August–5 September

First indication of Ella was a fairly active easterly wave in the vicinity of Longitude 50W on August 29th. Reconnaissance aircraft on a routine flight east of the Windward and Leeward Islands reported a wind shift and above average shower activity, but no indication of a cyclonic circulation. The wave moved through the islands during the 30th causing heavy rains and winds of 35–40 mph and lowest pressure of 1,010 mbs. Reconnaissance aircraft located a center by radar at Latitude 16.3N, Longitude 64.7W during the evening of the 30th and the first advisory was issued on Tropical Storm Ella. Highest winds were estimated at 55–60 mph near the center and the minimum pressure had dropped to about 1,009 mbs.

The storm intensified rapidly as it moved westward at about 18 mph in the eastern Caribbean and by the morning of the 31st, winds were estimated by aircraft at 85 mph. Winds were up to 110 mph by evening of the same date. The course had changed to the west-northwest during the day, as it skirted along just south of the Dominican Republic and Haitian coasts, causing torrential rains and considerable damage on the southern slopes of the mountains. It was thought that the hurricane passed over the southwest peninsula of Haiti. However, since the original intensity was maintained until it encountered the Sierra Maestra mountains in eastern Cuba, the center of the hurricane must have skirted along the immediate south coast of this peninsula. In fact, reports from the Haitian Meteorological Service indicate the hurricane followed a path parallel to the peninsula.

Reconnaissance aircraft on the 1st of September reported winds of 115 mph and lowest pressure of 989 mbs, or 29.20 inches, while the center was over the Caribbean Sea between Jamaica, Haiti, and eastern Cuba. The center passed inland over the Sierra Maestra mountains in Oriente Province in eastern Cuba a short distance west of Santiago and lost its hurricane strength. Hurricane force was never regained in its long path along the south coast of Cuba and across the Gulf of Mexico to the lower Texas coast.

As the storm moved west-northwest along the south coast of Cuba, a growing high pressure system was moving into the Atlantic States, and consequently gale warnings were hoisted on the lower east coast of Florida and in the Florida Keys, because of the anticipated increase of pressure gradient caused by interaction between the two systems. Highest winds had dropped to 40–50 mph in squalls but the area of squalls and rather heavy rains extended across Cuba into the southern Bahamas and the Florida Straits and Keys. The center crossed extreme western Cuba during the afternoon of the 3rd, moving towards the west-northwest at 12 mph. A west-northwest course was continued at 12–15 mph across the Gulf of Mexico, with highest winds generally about 50 mph; however, Grand Isle, Louisiana, reported gusts to 75 mph during a squall on the morning of the 5th and the *SS Jean Lykes* experienced a wind of 55 knots near Latitude 24.5N, Longitude 85.5W late on the 3rd. Highest winds on the Texas and Louisiana coasts were generally around 40 mph, with tides 2–4 feet above normal.

Damage was minor in extreme south Florida and in the Florida Keys, where strong to gale force winds and rather heavy rain occurred. A vessel, the *Erikboye*, was disabled southeast of Miami due to the storm and towed in by the Coast Guard.

Very little damage was reported in Texas. Rainfall was spotty and quite heavy. Galveston Airport reported 13.60 inches in three and a half days, with 8.44 occurring on September 7th. A shrimp trawler was lost on the Galveston Jetty on the night of September 3rd. One man was washed overboard from a snapper boat near Galveston on the same night.

6. HURRICANE FIFI, 4–12 September

On September 3rd the regular Air Force Gull Papa flight reported an increase in winds at 700 mbs, which was probably the first indication of the existence of the easterly wave that later developed into Hurricane Fifi.

By morning of the 4th the *SS Robin Hood* reported squally weather and pressure of 1008.8 mbs, or 29.79 inches, and falling pressure. Later that day the *Robin Hood's* wind veered from east to south but the development was so weak and slow that no cyclonic circulation could be found by the aircraft. The flight did observe cumulonimbus tops being blown toward the northeast and this was in agreement with a high level vortex over the extreme eastern part of the Caribbean Sea.

By afternoon of the 5th, a center of activity was located by aircraft and tropical storm Fifi was born at Latitude 15.1N, Longitude 55.0W, with highest winds 50 to 55 mph, and sea level pressure of 1,000 mbs, or 29.53 inches. This was the lowest central pressure observed during the life history of the storm, though equaled at a later date.

Fifi had been moving rapidly northwestward about 23 mph, but by early afternoon of the 6th the forward speed decreased to 16 mph and the storm increased to hurricane intensity. Fifi was located at Latitude 17.0N, Longitude 57.5W, at 0830 EST on the 6th attended by winds up to 92 mph north of the center. This was the maximum intensity of Hurricane Fifi.

The storm slowed to about 12 mph and highest winds decreased to 75 mph on the 7th. On the 8th, Fifi continued on a northwesterly course at 7 mph and maximum winds dropped to 60 mph. Prior to this time a jet maximum at high levels had worked around peninsular Florida and by evening of the 8th, it was located from the central Bahamas to Bermuda. It was this wind field that influenced the storm to make a turn to the north during the 9th and 10th. There were times that the jet appeared to be in a favorable position for an increased divergent field over the storm.

Fifi turned toward the northeast and accelerated during the 11th. The storm passed within 150 miles of the Leeward Islands and approximately the same distance southeast of Bermuda, and no loss of life or property damage was reported.

7. TROPICAL STORM GERDA
14–15 September

Tropical Storm Gerda developed in an easterly wave which was first identified about 400 miles east of the Lesser Antilles on September 11th. On the 12th, reconnaissance aircraft found no evidence of cyclonic flow or unusual weather in the wave, but on the following morning surface reports from the Windward Islands indicated that the wave had intensified. The same reports indicated some evidence of cyclonic circulation in the Caribbean Sea a short distance west of Martinique and aircraft confirmed its existence about noon on September 14th. At that time the cyclonic circulation was centered 75 miles southwest of Ciudad Trujillo, Dominican Republic, with highest winds 60 knots in the southeast quadrant and minimum central pressure of 1,004 mbs, or 29.65 inches.

Gerda passed over the southern peninsula of the Dominican Republic moving west-northwestward about 18 mph and evidently the mountainous terrain disrupted the cyclonic flow around its center. On the 15th, reconnaissance planes could not locate evidence of a circulation and reports thereafter indicated that tropical storm Gerda had degenerated into an easterly wave.

Three deaths were reported in Puerto Rico, and none in the Dominican Republic. Property and other damage apparently was slight.

8. HURRICANE HELENE
23–29 September

Hurricane Helene developed in an easterly wave that can be traced back to the Cape Verde Islands area on September 16th. Helene was one of the most intense and destructive storms of the season. Intensification of the wave began on the 20th in the vicinity of Longitude 50W when abnormal pressure falls and shower activity were noted. A weak circulation was located by reconnaissance aircraft on the 21st near Latitude 19N, Longitude 54W, with highest winds of 35 to 40 mph in squalls.

The slowly developing storm moved on a west-northwest course about 20 mph on the 22nd. Since an extensive anticyclone was developing in the upper troposphere off the south Atlantic coast during the period, the disturbance was moving into a much more favorable position for deepening. By the 23rd, winds had increased to 50 mph and the storm had slowed to 12 mph in forward speed.

On this date a large and very warm, upper tropospheric anticyclone, which had been located over Texas for several days, began a rapid eastward movement reaching the mid-

dle Atlantic coast on the 25th. This displacement resulted from a temporary change in the long wave pattern over the Northern Hemisphere. In the lower troposphere a mean trough was located off the Atlantic coast during September according to E. M. Ballenzweig. Without this large scale adjustment in the general circulation, Helene would have moved around the western edge of the Azores-Bermuda anticyclone, a safe distance off the United States coast, in the same manner as Becky, Daisy, and later Janice. In response to the arrival of the anticyclone in the upper troposphere, Hurricane Helene slowed to about 8 mph, veered to the left on a northwesterly course with rapid deepening in the manner described by H. Riehl and B. I. Miller as the hurricane moves under an intense anticyclone.

On the 26th, hurricane emergency warnings were issued for the coastal areas from Savannah, Georgia, to Cape Fear, North Carolina. At this time the center of Helene was located about 260 miles east of Brunswick, Georgia, moving northwestward toward the coast at 14 mph, and the hurricane center was forecast to reach the coast in the vicinity of Charleston. During the evening, it became apparent that Helene was gradually assuming a more northerly course and hurricane warnings were extended northward along the North Carolina coast to Cape Hatteras. The western edge of the hurricane eye came within about 10 miles of the coast at Cape Fear and a portion of the intense convective wall cloud passed over land in this area. After recurvature, Helene moved northeastward at an accelerated rate crossing Newfoundland on the 29th.

Hurricane force winds, acompanied by high tides and torrential rains, pounded the coastal areas from Cape Fear to Cape Lookout, North Carolina. The Weather Bureau at Wilmington recorded a maximum wind (one mile) of 88 mph and a peak gust of 135 mph. Both of these speeds greatly exceeded all previous records. Total rainfall at Wilmington during the hurricane was 8.29 inches. At Cape Fear winds were estimated at 125 mph with gusts to 150 to 160 mph. According to H. C. Sumner, the wind velocities and wind damage associated with Helene indicate a more intense hurricane than Hazel of 1954, but the fact that the center of Helene passed about 20 miles off the coast prevented the extremely high tides and wave damage associated with the 1954 hurricane. Tides were generally only about 4 to 5 feet above normal with one unofficial report of 9 feet. If the storm center had moved inland south of Cape Fear on a northwest course, the accompanying tides might have exceeded the 16 feet of Hazel. The Carolina coast missed a potential disaster of the first magnitude by a very close margin.

Although property damage was estimated at $11 million in North Carolina and $200,000 on the upper South Carolina coast, no lives were lost as a direct result of the hurricane and only one indirectly. No reports of major damage were received from the Canadian Maritime Provinces. The lack of any fatalities was due to extensive and detailed warnings, excellent detection and tracking by land-based and airborne radar, and effective community action with respect to evacuation and other protective measures. Evacuation of vulnerable beaches was complete in most cases.

9. HURRICANE ILSA, 24–29 September

Tropical storm Ilsa was located at Latitude 17.7N, Longitude 54.0W, on the morning of September 24th, having developed in a suspicious area that had moved from east of the Antilles. Highest winds were about 40 mph and central pressure 997.6 mbs, or 29.46 inches. Ilsa continued to increase in intensity and reached maximum force on the 26th, with winds of 92 mph and minimum pressure of 938 mbs, or 27.70 inches.

Ilsa turned northward on the 26–27th and afterwards slowly decreased in intensity, passing well to the east of Bermuda, and the issuance of regular advisories was discontinued on the 30th. No loss of life or property damage was reported.

10. HURRICANE JANICE, 5–11 October

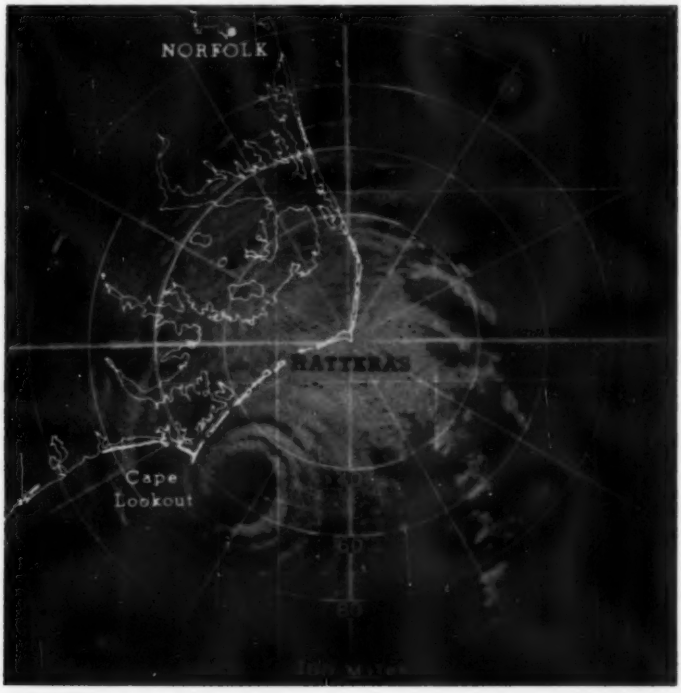
A fairly active easterly wave passed through the Lesser Antilles on September 30th and into the Virgin Islands on October 1st. By midday of the 2nd the wave had reached central Hispaniola, and 24 hours later extended from extreme eastern Cuba southward near Jamaica. By the 3rd the wave had moved to the central Cuba-Grand Cayman Island area.

This wave had been attended by heavy shower and thunderstorm activity from the central Caribbean northward across Puerto Rico, Hispaniola, Cuba, and into the Bahamas as it progressed westward. A broad flat cyclonic circulation was evident southwest of Jamaica on the 3rd and by the 4th this circulation was located a short distance southwest of Grand Cayman Island. Reconnaissance aircraft on this date found no closed circulation. Squalls in the northern semicircle were attended by maximum winds of 40 mph and the lowest pressure at sea level was 1,010 mbs. On the 4th the aircraft found a large but very weak circulation with minimum pressure of 1,008 mbs, or 29.77 inches, and maximum winds of 25 mph.

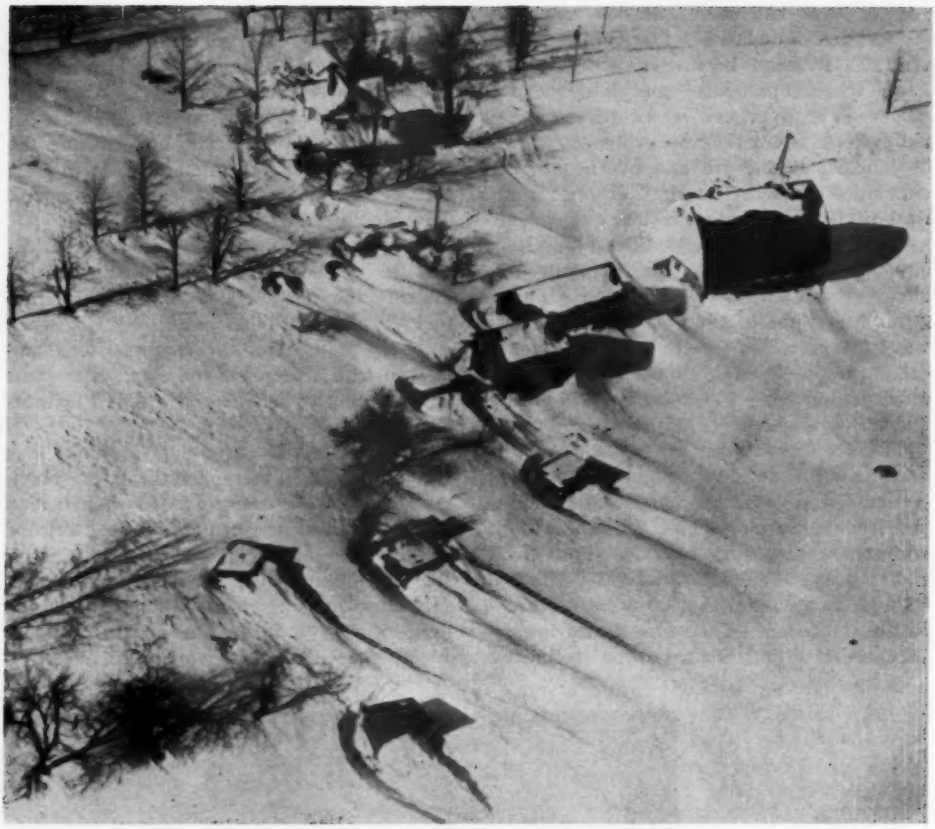
The weak circulation drifted slowly north-northwestward during the night and gradually became better organized and by afternoon of the 5th had developed into a tropical storm with the center just south of the central Cuban coast. Winds had increased to 40 to 45 mph in squalls within 60 miles north and east of the center. The storm turned towards the northeast and crossed Cuba during the night and by midday of the 5th was centered between New Providence and Andros Island in the central Bahamas. The storm was gradually increasing in intensity and size and accelerating in forward speed during this period and reached hurricane force during the evening of the 6th. Minimum sea level pressure at this time by dropsonde was around 996 mbs, or 29.41 inches.

The hurricane drifted slowly north-northeast to northeast, then began accelerating towards the northeast to east-northeast on the 9th and continued until the 11th, when it began losing tropical characteristics and merged with a deep low pressure system that moved from the Canadian Maritime Provinces into the North Atlantic.

Minimum sea level pressure in Janice was 968 mbs, or 28.59 inches, on the 10th. Highest winds were estimated at 90 mph over a small area near the center of the hurricane on the 7th and again on the 10th, with slightly lower speeds on intervening days. Minimum pressure in the Bahamas was 988 mbs, or 29.176 inches, at Harbour Island, Eleuthera, with highest wind of 63 mph.



A radar view of the eye of Hurricane Helene on afternoon of 27 September 1958. The radar was located at Cape Hatteras, and the eye a short distance southeast of Cape Lookout, North Carolina. Range markers are 20 miles. Courtesy, *Mariners Weather Log*, U. S. Weather Bureau.



An aerial view shows pattern of drifting snow around a farm house at South Canaan, Wayne County, about 20 miles north of Scranton, Pennsylvania. A 30-inch snowfall on 16–17 February was followed by gale force winds to isolate many outlying farms for a week and more. Wide World Photos.

Some Noteworthy Snows of 1957–58

DAVID M. LUDLUM

THE OLD-FASHIONED WINTER IN THE NORTHEAST

THE frequency of heavy snowstorms in the Northeastern States provided the outstanding feature of winter 1957–58. It has been many years since so many snow-bearing coastal storms moved up the Atlantic seaboard. Two of these occurred early during the first half of December: the first on the 3rd and 4th deposited heavy amounts along the coast from Virginia to New Jersey with some stations reporting up to one foot; the second on the 11th dumped 2–8″ on much of New Jersey, eastern New York, and New England.

Three major storms affected some portions of the Northeast during January. The first of two coastal storms on the 7–8th left up to 12″ in southern Maryland, 15″ in southern New Jersey, and up to 20″ in east-central New England where several stations reported the fall as the heaviest in modern records. The band of heavy snow covered a strip only about 30–50 miles wide. The second January

storm extended from the 14–19th to produce up to 2 feet in eastern New York, and 8–15″ in New England. The third storm on the 20–21st piled up 6″ or more new snow in parts of New York and New England, after blanketing with 8–15″ a wide belt extending from northeastern Kansas to Lake Michigan and eastward. At the close of January snow depths in northern New York at lower levels ran from 18–24″, and in New England about the same amounts except for very heavy accumulations around the White Mountains (Pinkham Notch at 2,000′ and 53″).

During the first week of February another Midwestern storm, after leaving 4–10″ of new snow in parts of Missouri and Illinois, produced a foot in the central Appalachians, 7–10″ along sections of the New Jersey coast, and 6–7″ in southeastern New England. This was followed by a coastal storm on the 7–9th which left 10″ additional snow in eastern portions of Pennsylvania and New York State and 18″ in northern New England. A raging blizzard followed along the southeast shores of Lake Ontario and inland a few miles with winds up to 50 mph in gusts, drifting 12–24″ of new snow into enormous drifts to block roads, close schools, and curtail business activity. The Syracuse area was especially hard hit by the snow blockade.

THE GREAT ATLANTIC COAST SNOWSTORM OF 1958

Meteorological history was made on 15–17 February when an enormous storm swept from the Gulf of Mexico up the Atlantic seaboard and produced the most widespread, heavy snowfall of the present century. From Alabama, where depths up to 16″ were reported in local areas, to Canada and beyond the snowfall was phenomenal for depth combined with areal extent. In interior Georgia and the Carolinas depths averaged about 8″, increased to 12″ in Virginia, and exceeded 30″ at many points in eastern Pennsylvania, the Catskills of New York State, and in northern New England. It gave coastal Boston its heaviest 24-hour fall in Weather Bureau history, and raised the total snow cover at inland Burlington, Vermont, to an all-time record. (A detailed account appeared in *Weatherwise*, April 1958, p. 71.)

At the conclusion of the Great Snowstorm snow cover at many Northeastern regions, accustomed to heavy snows, approached or exceeded record depths. At Hanover 47″ of snow lay on the Dartmouth College campus, and at nearby Lebanon airport the depth was 59″. Pinkham Notch, a low level location in the White Mountains, reported 70″. In Vermont Montpelier airport had 52″, and Cavendish 53″. In eastern Massachusetts at low levels depths approached 24″ as they did throughout much of interior Connecticut except for lofty Norfolk (1380′) where a 37″ cover existed. Syracuse in central New York State received snowfall from all types of storms whether of the coastal, general cyclonic, or lee shore variety and piled up an amazing total of 72.6″ in February, the greatest ever recorded there in a single month.

MARCH

Two memorable snowstorms struck the Middle Atlantic States and New England soon after mid-month of March 1958. The first was especially severe from the Catskills of New York State across central and southern New England with a wet, sticky fall which amounted to 20″ over a large area. With temperatures near freezing the snow built up around wires and poles to cut off power lines; the entire southern half of New Hampshire was without electric power. Drifts with depths up to 15 feet in north-central Massachusetts blocked highways for many hours.

The Eve of Spring Snowstorm struck much of the same area which had been hit on 14–15 March, but had a much larger scope. The area of greatest devastation lay in the Middle Atlantic States from the Appalachians to the coast, though southern New England also felt its paralyzing power. Without doubt, it was the most disastrous snowstorm in this major industrial and residential area since the coming-of-age of the electric wire for power and communication.

From northern Virginia a belt of heavy precipitation spread across central Maryland, eastern Pennsylvania, most of New Jersey, the southern Hudson Valley of New York, and into Connecticut and Rhode Island. Many locations on both sides of the Mason-Dixon Line in Maryland and Pennsylvania received over 4.00″ of precipitation, most of it as a wet, sticky snow. Snow depths up to 40″ were measured in southeastern Pennsyl-

vania, up to 33″ in Maryland, to 23″ in extreme northern Virginia, to 30″ in northern New Jersey, to 25″ in New York State, and to 18″ in northwestern Connecticut. So critical was the temperature balance between rain and snow that many cities had their suburbs buried in mountainous snows while downtown streets had only a small, wet accumulation. Never before in the United States did a single snowstorm create such economic loss. (See *Weatherwise*, June 1958, p. 109 for a full account.)

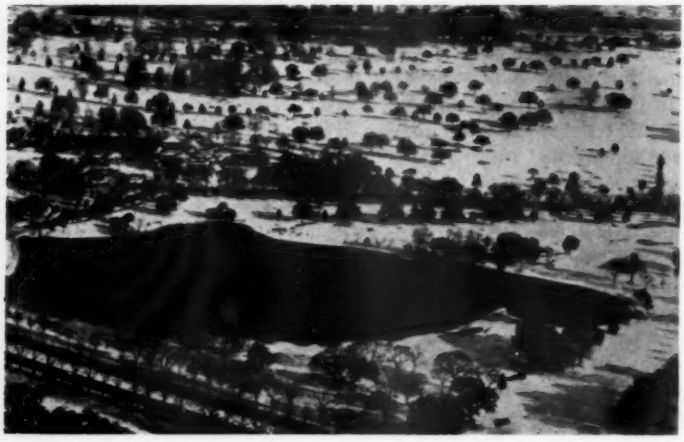
Snow depths in New England at the conclusion of the precipitation period of 19–22 March were close to March records. At Norfolk in Connecticut 50″ covered the ground on 22 March; this was reduced to 30″ by 1 April, and finally disappeared by 21 April. In the hills of western Massachusetts the snow bowl at West Cummington was filled with 38″ on 22 March, 22″ on 1 April, and was finally bare by the 16th. At low levels in Vermont and New Hampshire the snow cover generally disappeared on the 17th or 18th, but at Pinkham Notch in the northern shadow of Mt. Washington the 72″ cover of 22 March remained until the 2nd of May. In Maine the deep cover at lower elevations was generally gone by 22 April.

GULF OF MEXICO SNOW

The most unusual snow of the season occurred on 12–13 February along the shore of the Gulf of Mexico and at sea, an area which had not witnessed a comparable storm since 1899. A depression moved across the north-central Gulf of Mexico on a track almost parallel to the coastline from Louisiana to Florida where frigid air had already penetrated. The circulation around the low threw moisture northward over the dome of cold air overlying coastal areas. Temperatures dropped below freezing even at the mouth of the Mississippi River on the nights of the 12th and 13th, and snow spread from coastal Texas eastward. Some parishes near the coast, such as Vermillion Locks in Louisiana, received 5″, and at Burrwood, the southernmost point of Louisiana jutting out into the Gulf of Mexico at Latitude 29N, the fall measured 2″.

Snow fell on ships as far as 150 miles from shore, and amounts offshore, closer to the center of the disturbance, were probably heavier than at coastal points. In general, the snowfall did not extend more than 75 miles inland. As the storm moved eastward, it spread a covering of white to a depth of 3″ in Alabama and Florida. Tallahassee Airport measured a 3-inch cover to equal the modern record for the deepest snow cover in Florida's experience. At Jacksonville, on the east coast near the Atlantic, a fall of 1.5″ accumulated, the first measurable snowfall there in 59 years. Snow was observed as far south as Gainesville, but it melted as it fell at that southerly latitude.

February was a snowy month over the Gulf States. A fall on the 10th left 4″ in northeastern Louisiana and across northern Mississippi. Then on the 14–15th very heavy falls spread across the northern parts of Lou-



A city park at New Orleans wears an unusual white blanket on 13 February 1958, as two inches of snow and sub-freezing temperatures visit the city. It was the heaviest fall since 1899. The record snow storm at New Orleans occurred in February 1895 when 8.2″ fell. Wide World Photos.

isiana, Alabama, and Georgia. A band with 10″ plus crossed northern Alabama and depths reached record accumulations, the top figure being 16″ at Haleysville. This comprised the commencement of a gigantic snowstorm which spread a pattern all the way to the Canadian border and beyond. It is interesting to note that a section across south-central Alabama received no snow at all during this unusually snowy February in the Southland. The section above Montgomery was too far north to get any flakes from the Gulf storm, and too far south to have freezing conditions during the great northern storm.

Florida had the unique experience of seeing snow fall in two consecutive months. In addition to the February 12–13th storm, snow flurries visited the peninsula on 8 January, and were noticed as far south as the Tampa Bay area.

PLAINS BLIZZARD

The only serious blizzard conditions over any sizeable area of the Great Plains occurred in South Dakota and adjoining parts of western Nebraska and Kansas on the closing days of February. A slow-moving complex pressure disturbance pushed across central Kansas on the 26th and deepened at a phenomenal rate. Barometers reached all-time lows in Oklahoma, northern Texas, and western Arkansas on the night of the 26–27th. These extremely low pressures, under 29.00″, created a steep pressure gradient northward and brought cold Arctic air into the western part of the circulation. The contrasting air masses loosened precipitation in unusual quantities and variety.

East of the frontal line, which ran north-south through central Kansas, east-central Nebraska, and eastern Dakotas, torrential rains, in many places the greatest ever recorded in the month of February, deluged the area. Further west near the front a zone of ice and glaze stretched from Kansas to the Dakotas, making all movement by land treacherous. West of the front the cold winds accompanied by heavy snow reached gale force and near-blizzard conditions resulted. Traffic was halted and schools closed as the wind-whipped snow reduced visibility to zero. The greatest snow accumulations were generally near and west of the Missouri River. Pierre in central South Dakota had 13″ new snow, and in the open country around Winner the prolonged winds caused drifts as high as 12 feet.

The heavy snowbelt extended southward into western Kansas. By the end of the month most areas in the Wheat State west of 99°W had substantial snow cover. At Long Island the greatest post-storm depth of 17″ was reported. March proved to be the snowiest month in a long time on the Kansas plains. Snow fell almost daily until the 17th in most western counties to pile up record depths. On the 13th Healy measured a covering of 26″. Many stations had March totals of 40″ or more. The greatest was 45.8″ at Healy. At Quintard there was continuous snow cover during the entire month of March, the final measurement being 9″ on the 31st.

MONTANA SNOW

A record-breaking, late season snow fell in much of Carbon, Stillwater, and Sweetgrass counties in southwestern Montana on 22 and 23 April. The area lies just north and northeast of Yellowstone National Park. Snowfall totaled 55″ for the storm at Red Lodge, 48″ at Nye, 61″ at Nye Mouat Mine, and 72″ at Mystic Lake. Over 6.00″ of moisture from the storm were measured at Red Lodge and Mystic Lake. The north and east slopes of the Absaroka Mountains were the hardest hit, with highways closed for a day or more. The deepest snow cover was measured at Mystic Lake on the 23rd—60″ (on that day 43″ fell). The light density snow settled quickly to 21″ at Mystic Lake by the 25th. Further snows during the next days increased the cover, though by the month's end Mystic Lake had only 18″ to greet the month of May. The total fall at the latter place for April equaled 96″.

Temperatures at Mystic Lake during the big snow on the 23rd ranged from a minimum of 20° to a maximum of 32°. On both the preceding and following days, the mercury had topped 40° at that 6,558′ elevation.

PACIFIC MOUNTAINS

The snow season in the far western mountains divides into two parts. The Cascades of Washington and Oregon had their greatest totals in December and January when a series of cyclonic disturbances were sweeping inland a short distance northward over British Co-

(Continued on page 35)

The Floods of 1958

ELMER NELSON, *U. S. Weather Bureau, Washington*

THE most destructive floods during 1958 were the June overflows in the Wabash and White River basins in Indiana. The main damage occurred as the crests moved down the rivers, overflowing sections of populated cities and spreading destruction over crops, in most cases too late in the season for replanting. The $48 million crop loss was probably the greatest of all time in this section of the country.

The flood causing the greatest loss of life during 1958 was the flash-flood on the East Nishnabotna River in southwestern Iowa which claimed 19 lives, one of the most tragic floods in Iowa history. It resulted from a series of thunderstorms which dumped over 12 inches of rain in a 3-hour period.

The Charles and Neponset Rivers in the Metropolitan Boston area of Massachusetts experienced the worst January flood ever as a result of 7.08 inches of rain during the period from 15 January to 29 January. A total of 9.54 inches was recorded for the whole month which is the greatest for January on record for Boston. The crest on the Charles River at Charles River Village was the fourth highest on record. Several highways and many basements were flooded; some bridges were closed but none destroyed. Flooding reported elsewhere during January was mostly light except for serious local occurrences southwest of Corpus Christi, Texas.

The most damaging floods during February occurred in the Sacramento Basin in California towards the end of the month. Property damages were estimated between $6 and $7 million. The upper Sacramento River reached its highest level since January 1943. Downstream from Red Bluff, the Sacramento attained its highest point since 1942. Three communities, Tehama, Hamilton City, and Grimes, were evacuated as a precautionary measure. The west side tributary streams of Stony and Cache Creeks reached record high stages. Other floods of importance were reported in the Nueces and Guadalupe River Basins in Texas. While overflows did not exceed the all-time records, it was one of the larger inundations in the Nueces Basin. Some 300 persons were evacuated because of high water. The flood in the lower portion of the Guadalupe, where the rain was the heaviest, was the second largest since records began, being exceeded only by that of July 1936.

There was considerable light to minor flooding during March with very little property damage reported. Some county highways and bridges were damaged from local flash types in central and southern Alabama.

Near-record to record stages were reached during April on the Russian and Pajaro Rivers and on tributaries of the northern San Joaquin River in California; the crests were due to extremely heavy precipitation during the first week of April. In the Central Valley drainage, the precipitation during the first week of April exceeded that normally received during all April, May, and June. Large sections of agricultural lands adjacent to all tributary streams were inundated. Several thousand persons were evacuated from their homes from the rampaging waters on creeks in the San Francisco Bay area. Three deaths by drowning were reported.

Severe floods developed in the East Gulf of Mexico drainage and in the Red Basin near the close of the month. A near record crest occurred on the Ouachita River in Arkansas. Major floods were developing on the Little River in Arkansas and on the Sulphur and Cypress Rivers in Texas.

Severe flooding occurred in streams in southern Arkansas, northern Louisiana, Mississippi, and eastern Texas during May. Stages on several rivers in this area reached record to near-record proportions. Many families in the area were forced from their homes. Serious flooding also occurred in the headwaters of the Big Sandy River Basin in southwestern Virginia, eastern Kentucky, and southwestern West Virginia. Some of the highest stages in 10 to 18 years were reached on streams in eastern North Carolina forcing several families from their homes.

The greatest summertime flood of record occurred in the Wabash and White River Basins in Indiana during June. The river levels were generally the highest since May

1943 and in some cases the highest since March 1913. A record crest was reached on the Mississinewa River at Marion, Indiana. The total damage was estimated at $57 million, with about 1.25 million acres under water. The Red Cross estimated that 2,000 homes were damaged by the waters: fourteen homes were completely destroyed and 54 others received major injury.

Flash floods occurred along the creeks and rivers that head in the Edwards Plateau escarpment in Texas from the heavy rains accompanying tropical storm "Alma" as it moved inland south of Brownsville, Texas, on 15 June. The stages on the Sabinal, Seco, Blanco, and upper Hondo were the highest in several years.

Major flooding occurred in several streams in Illinois, Missouri, Kansas, Iowa and Nebraska during July. Record stages were exceeded on the lower Raccoon in Iowa, the Salt River at New London, Missouri, and the Arkansas River at Great Bend, Arkansas. A severe flash flood on the East Nishnabotna in Iowa resulted in the loss of 19 lives and millions of dollars damage. Another occurrence in West Virginia took the lives of a mother and her six children as her home was swept away by the raging waters. The flooding on the Shenango River in Pennsylvania was the worst since 1913. The lower Missouri reached its highest level since 1951 in the reach below St. Joseph, Missouri.

A record crest occurred on the Knik River near Palmer, Alaska, on 18 June, caused by the release of water from Lake George which broke through its ice barrier on 16 June. Several families were forced to evacuate their homes. The Alaskan Railroad and the Palmer Highway were damaged by the flood. Severe

(*Continued on page 35*)

The banks of the Wabash River at Delphi, Indiana, could not contain the June flood waters. An inundated portion of US 421 can be seen in the foreground along with many acres of rich farm land on which crops were destroyed with an estimated loss of $57 million. Wide World Photos.

Weatherwatch

Data by Office of Climatology, USWB.

Winter Opens: Warm in West, Cold in East

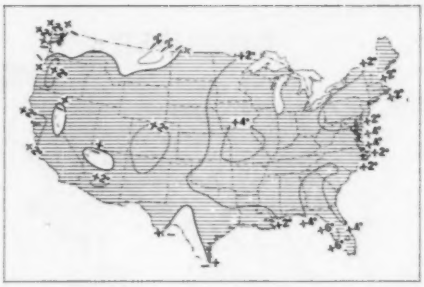
DAVID M. LUDLUM, *Editor*

CIRCULATION—The circulation pattern which had caused a mild, dry October in the western half of the country continued to dominate the weather scene in the first half of November. It was a repetition of the basic high index pattern with fast westerly flow sweeping the country from Pacific to Atlantic in company with a swift jet stream entering the country over Oregon and Washington and rushing eastward to exit over the North Carolina coast. Inflow from the Pacific Ocean under high index conditions has featured most months since the middle of last spring.

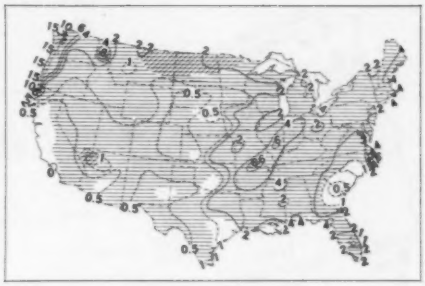
The mean upper-air pressure maps for 1–14 November over the United States showed little departure from normal values. The most significant feature was the flattening of the ridge over western Canada and the Plateau and Pacific states of the U. S. This, of course, relieved the blocking effect which had been present in western Canada during the final ten days of October and had moved wintry conditions into the Far West. Arctic air, now excluded from the United States, was swept eastward by the prevailing fast westerly flow through southern and central Canada.

A marked disturbance was in progress across the country as the month opened, but it cleared the Atlantic coast late on the 2nd. A fast-moving low then entered over the State of Washington on the 3rd, lashed the Northwest with whole gale and hurricane winds, and pushed rapidly eastward to Minnesota, where it turned northeastward and moved to northern Labrador. A northerly stream, the only such occurrence during 1–14 November, followed on the 4th and 5th to give the Northwest and the Plains states a taste of what the coming winter had in store.

Temperatures during this period in the West soared to record heights under the influence of a southerly flow induced by disturbances moving along the Canadian border. In Nevada and Utah on the 8th and 9th, the mercury reached new all-time November levels. On the very same day such distant locations as Salt Lake City, Utah, and West Palm Beach, Florida, both experienced their warmest readings for so late in the season. For the week ending 9 November, the temperature averaged as high as 10 degrees above normal in the central Plateau. And during the following week the center of the heat mass moved eastward to the central Plains and central Mississippi Valley—Kansas City had a plus 18-degree departure for the week ending the 16th. Further east and southeast from Missouri eastward to Pennsylvania and southeastward to Georgia many sta-



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.



Total Precipitation in inches. USWB chart.

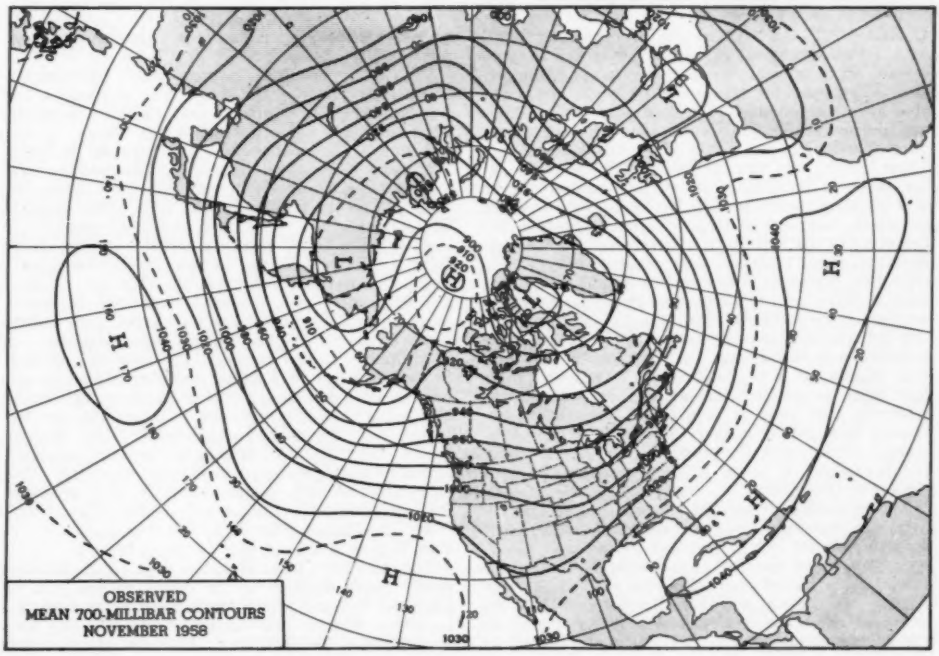
tions broke their highest-so-late-in-the-season marks as tropical air poured northward under a regime of sunny skies.

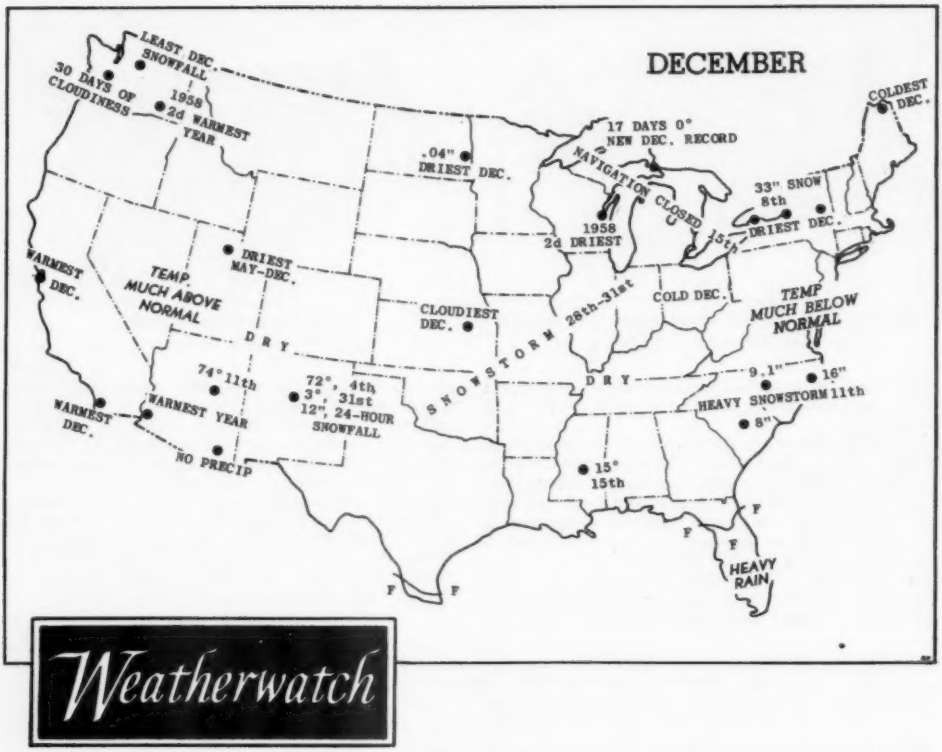
A major change in the circulation pattern developed as the second half of November made its bow, a period which witnessed two major fluctuations from high to low index and produced much interesting meteorological material. The first intimation of the shift could be detected on the 10th when a closed circulation pattern appeared aloft over central California, although well to the north over British Columbia the westerlies remained undisturbed and still streamed eastward to prevent Arctic air moving toward the California circulation. The trough over California worked its way eastward very slowly, accompanied by a surface low along the Canadian border, and reached Oklahoma by the 14th at a time when the northern surface low had pushed on to Hudson Bay.

By the 14th another closed low circulation feature had appeared over California, this time accompanied by a marked surface disturbance over Nevada, much further south than the preceding surface low. Upstream to the west of this developing trough, the Pacific ridge built up rapidly into Alaska. This

(*Continued on page 34*)

The upper-air map below shows the pattern of air flow for November at about 10,000 feet, on which the average weather largely depends. The contours lines represent the mean height of the 700 mb. pressure level. Figures are in tens of feet: 1020 = 10,200 ft., 980 = 9,800 ft., etc. Chart by Extended Forecast Section, USWB.





Weatherwatch

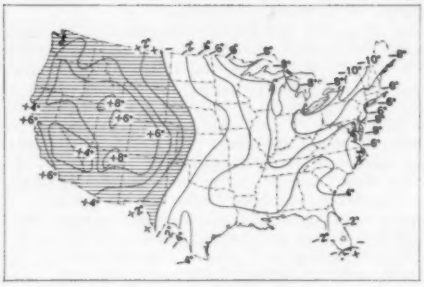
CIRCULATION—The month of December opened with a reestablishment of westerly flow and a trend toward much milder conditions across the entire nation. Temperatures rebounded from the unseasonable lows reached over the Thanksgiving Day holiday and weekend when several new November minimum marks were set in the Ohio Valley, the lower Lakes region, and the Northeast. In fact, the entire story of the December weather parade can be told in the eastward progression of a bulge of warm air which occupied the Pacific Southwest in late November and the first days of December. This eastward progress, however, was challenged by a bitterly cold northerly flow from the depths of the Canadian Arctic whose supporting ridge gave ground very gradually until the 15th. On the 4th the northerly air stream surged across the border to drop the mercury well below zero in Montana for the first time this winter in the parts of the state where there had been no previous below zero readings in the relatively mild year of 1958. This initiated an extremely cold period further east; in the upper Mississippi Valley and the upper Lakes region many points experienced the most persistent cold on record for early December.

The dynamics behind the invasion of cold air lay in a large anticyclone of great magnitude which commenced to build over the Yukon Territory of northwest Canada on the 3rd as the central Pacific ridge extended northward again. Pressure reached 1052 mb (31.06″) on the 4th, and thereafter for four days the dome of dense air remained almost stationary, all the while maintaining a peak pressure of 1052 mb or above. On the 6th the map report indicated a peak pressure of 1059 mb (31.27″).

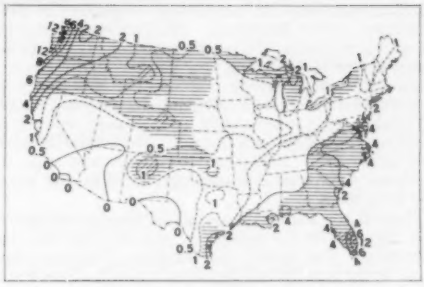
With an upper-air low pressure center hovering between Lake Superior and James Bay in Canada, the way was open for a rush of cold air into the northern Plains and the entire Mississippi Valley. Temperatures at International Falls in extreme northern Minnesota reflected the intensity of the cold air mass by not rising about + 3° from late on 5 December until late on the morning of the 16th! The absolute minimum reached − 34°, and the daily minima remained below − 16° from the 6th through the 15th! Quite a cold snap for the second week of December!

On the morning of the 6th the zero line dropped into Wyoming and Nebraska, and with a second surge of Arctic air on the 9th it carried into central Indiana, central Illinois, and northern Missouri. A third blast engulfed much of the area on the 12th to include parts of Kansas, much of Missouri, and western Ohio in the zero circle. Madison, Wisconsin, had below zero minima continuously from the 6th to the 16th, the longest such stretch in the 80-year records there. At Des Moines the mercury remained below freezing from the 5th through the 15th. The morning of the 9th was generally the most severe in the larger Midwest cities: − 16° at Sioux City, Iowa; − 18° at Minneapolis; − 8° at Chicago; − 6° at Fort Wayne, Indiana; and Indianapolis − 5°.

The stationary front along the crest of the Rockies finally broke through to the Plains on the 15th to push the mercury above freezing after the long depression. Kansas City registered 38° that day and soared to 54° the next day. Eastward displacement



Departure of Average Temperature from normal in degrees Fahrenheit. USWB chart.

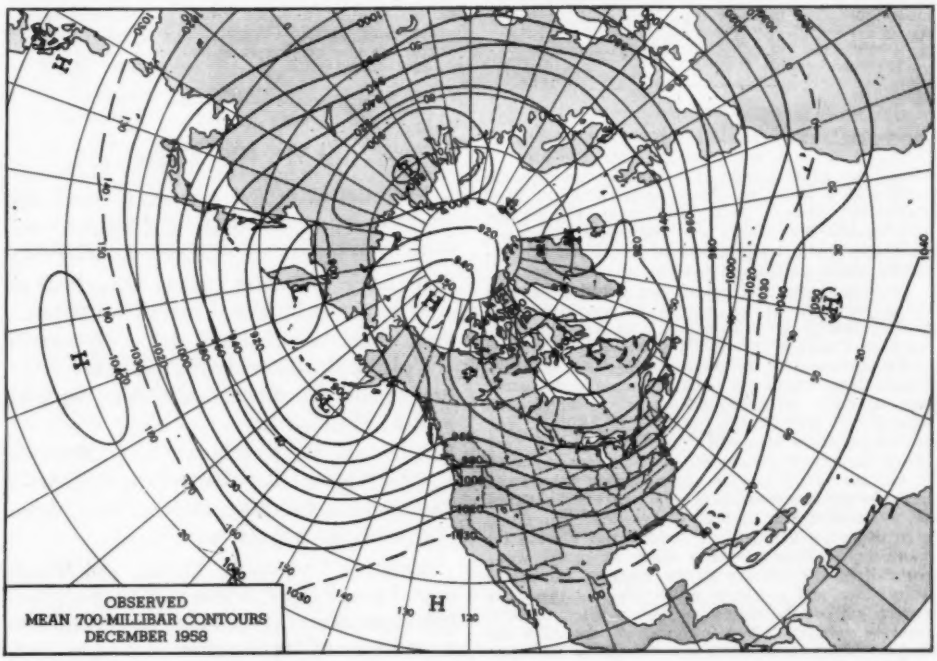


Total Precipitation in inches. USWB chart.

of the pressure systems and thermal zones provided the theme for second half of December. Most important in the shift was the movement of the western ridge from a mean position over the Pacific Coast states (120° W); it was displaced eastward on the mean map for 16–31 December to a position along 110° W meridian, or roughly on the Salt Lake City-Edmonton axis, or 750 miles east of the former position. In conjunction with the northeastward migration of the upper-air low from its erstwhile haunt in western Ontario, first to Hudson Bay and then eastward to the coast of Labrador, the upper-air circulation underwent important changes. This threw the main stream of northwesterly flow out of the Arctic some 500 miles eastward, over the lower Lakes and the Northeast. Whereas the center of the greatest departures from normal for the week ending the 14th lay over Minnesota, for the week ending the 21st the coldest area stood over Vermont, and for the following week over the coast of eastern Maine.

The low in northeastern Canada provided the principal pressure feature of the last two weeks of December just as the northwestern Canadian anticyclone had been outstanding for the previous two weeks. On the 16th the upper-air low stood over central Hudson Bay where it remained until the 22nd when it quickly moved 15 degrees eastward to the coast of Labrador, remaining there until the 27th to provide a mecca for cyclones and keep the northwestern Atlantic Ocean in turmoil over Christmas.

The presence of this deep low stimulated a continued northwesterly stream of bitter, polar air into the lower Lakes and the Northeast to prolong the



unusual December cold spell. It was the coldest 12th month since the memorable December of 1917 generally in the Northeast. At Caribou, at the tip of northern Maine, the temperature averaged nine degrees below normal, and did not go above freezing during the entire month. It was the persistency of the cold rather than the extreme degree which made December 1958 outstanding—the lowest reading at Caribou was only $-22°$, well above the all-time low of $-41°$. And there were no zero days at Caribou, days when the mercury failed to rise above the zero mark.

Out on the Pacific Coast of California and generally throughout the Southwest just the opposite was occurring. The central and southern California coast zone again had record-breaking warmth—San Francisco, Los Angeles, and San Diego had their warmest Decembers of record, to conclude the warmest year in history dating back to 1871. The warming of the coastal waters along the California coast and the related effect on the temperatures of the Southwest provided the most spectacular and significant highlight of the entire 1958 weather story.

December proved a notably dry month—about two-thirds of the nation reported only light precipitation (less than ⅓rds of normal). The only areas receiving heavy amounts were in the Pacific Northwest and inland to Montana where the westerlies again brought in abundant moisture. Most of California remained very dry as the winter rainfall season lagged far behind seasonal figures. December reversed the fall rainfall pattern in the South Atlantic states, favoring them with copious snowfall and rains as depressions moved up from the Gulf of Mexico. Elsewhere in the East and Midwest it was very dry. Rochester, New York, had the driest December since 1835 with only 0.62″ precipitation. Just 75 miles to the east on the shore of Lake Ontario, the area around Oswego was buried under almost 100 inches of snow, but such lee-shore snowbursts are usually of very light density.

November (*Continued from page 31*)

turned the air flow over the Pacific states into the north with a result that Arctic air invaded the West Coast and Plateau states, and many records for early season low marks were set even on coastal California where temperatures had been almost constantly above normal for months.

The disturbance in Nevada on the 14th grew into the major storm of the month and provided many weather headlines in the papers. As it passed eastward to Colorado on the 15th, blizzard conditions broke out over the northern Rockies and northern Plains; these continued until the main disturbance, now actually an energetic secondary which had formed over New Mexico on the 16th, made an exit northward from Minnesota on the 18th as a very severe November storm with central pressure down to 973 mb (28.73″). The storm system was forced to move directly northward over the eastern Plains by the downstream upsurge of the ridge which had been overlying the Gulf of Mexico and Florida for many days. Thus, northerly winds swept the western half of the country in the wake of the severe disturbance, and southerly winds engulfed the entire eastern half of the nation setting up a terrific temperature contrast. For instance, on the 16th the mercury dropped into the low 20s along the coast of central California, while 80-degree readings were reached as far north as Virginia.

Air flow over the Pacific Northwest, after experiencing the quick Arctic deep freeze, quickly returned to a westerly pattern on the 18th and continued to bring mild Pacific air into the country until the 22nd. Temperatures rebounded all over the West on the 18th with the warm surge reaching the Atlantic states on the 20th. High index of westerly flow seemed again reestablished.

The final phase of November's fluctuating character commenced to take shape on the 22nd as the Pacific ridge showed a marked development northward into Alaska and beyond toward the North Pole. A great blocking anticyclone appeared over eastern Alaska and the Yukon Territory of Canada where a great reservoir of frigid air was being harbored. With the development of a low pressure trough along the northern Rockies of the United States on the 24th and its passage eastward, Arctic air commenced to move southeastward and temperatures went below zero in Montana on the 25th. By the 26th an enormous high pressure ridge extended from central Canada to the Gulf coast of Texas, and cold air was able to ride down the eastern slope of the ridge and stream into the United States. By Thanksgiving Day, the 27th, the frigid blasts had penetrated all the way to the Atlantic Coast.

The final event of this interesting month came with the development of a low in the west Gulf of Mexico on the 27th along the fringe of the Arctic air mass. This moved northeastward along the eastern slope of the Appalachians, flanked by cold Arctic air to the west and by warm tropical air to the east—a situation bound to produce a very intense low pressure system. A major snowstorm broke out over the Ohio Valley and northeastward which approached November records. Early on the final day of the month Arctic air appeared triumphant occupying all areas of the United States except Washington and western Oregon where another surge of Pacific air was seeking to enter.

AMS Elections

The election of five new members of the seventeen-man Council of the AMS were announced at the New York meeting in January:

Prof. Louis J. Battan, Assoc. Dir., Inst. of Atmospheric Physics, Univ. of Arizona.

Prof. Jule G. Charney, Dir., Dynamical Weather Prediction Project, M.I.T.

Prof. Henry G. Houghton, Head, Dept. of Met., M.I.T.

Dr. Donald P. McIntyre, Chief, Research and Training Div., Met. Service in Canada.

Prof. Hans A. Panofsky, Dept. of Met., Pennsylvania State University.

Secretary Thomas F. Malone and Treasurer Henry De C. Ward were reelected. President Sverre Petterssen is serving the second year of his two-year term.

Floods (*Continued from page 29*)

flooding occurred along several streams in eastern Puerto Rico on 21 June due to torrential rains. At Humacao and Arroyo, the rivers rose higher than during any previous flood, heavy damage and four deaths resulting with approximately 75 homes destroyed and 1,000 persons homeless.

The most damaging floods during August were of the flash variety in the Ohio Basin in the Charleston, West Virginia, area. Water in the Kanawha Two Mile Creek Basin was reported 15 to 20 feet higher than at any previous time. The Holly River, a tributary of the Elk River, reported its highest stage at Holly, W. Va., in 35 years. The Arkansas River also reached a near record stage at Hutchinson, Kansas, early in August.

Damaging floods occurred during September along the Rio Grande at Presidio, Texas, the Middle River in Iowa, and along the Republican in Kansas. The Rio Grande situation at Presidio was the worst since 1932, due to a heavy flow from the Rio Conchos in Mexico. Major damage resulted to the cotton crop which was practically a complete loss. The inundations on the Middle River came from rain in excess of 12 inches in the headwaters in an eight-hour period. Crop damage again was heavy in the lowlands. Two dwellings were destroyed and 13 other houses were damaged in Casey, Iowa. The crests on the Republican River at Clay Center and Wakefield, Kansas, were the second and third highest stages of record. There were considerable flash overflows from excessive rains in northeastern Texas.

The most important flooding during October and November took place in southern Texas on the Rio Grande below Falcon Reservoir, and was rather extensive on the Mexican side. Considerable amounts of farm land were under water on the American side from Rio Grande City to above Mission, Texas. There are no levees along this reach of the river and the small villages of Abrams and Los Ebanos were deluged and had to be evacuated.

Flooding during December was very sparse and light and confined to the Carolinas, Virginia, and western Washington.

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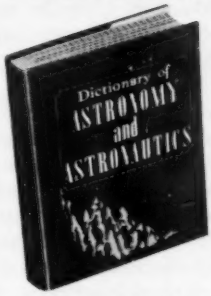

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1958 (*Continued from page 5*)

The National Science Foundation Responds. The responses to the recommendations of the Academy have been most gratifying. The National Science Foundation has established a separate Atmospheric Science Program, with the aim of providing support for basic research in meteorology and furthering work in weather modification. The Foundation is moving vigorously into this new area of responsibility, with emphasis not only on research but also on education and manpower.

The Universities Respond. Early in 1958, fourteen universities * with strong interests in meteorological research and education formed the University Committee on Atmospheric Research (UCAR). The main task of this Committee was to prepare plans for implementation of the first two recommendations in the aforementioned report of the Academy. To ensure perfect coordination with the related activities of the Society, the members of UCAR were appointed as the Society's standing Committee on Education.

With a speed which is rarely seen on a university campus, the UCAR prepared plans for the formation of a corporation of universities to operate the National Institute. A small but hard-working planning staff was appointed in summer 1958; planning conferences were held in rapid succession; and, as 1958 draws to an end, skeletal blueprints of a National Institute of Atmospheric Research and plans for strengthening the universities' activities in meteorology are taking form.

The Society Responds. The third recommendation of the Academy's Committee, namely the one that deals with the manpower problem, was addressed to the American Meteorological Society. This recommendation has been translated into several major projects which, when placed side by side, add up to a comprehensive plan; they also add up to a sum of the order of one million dollars to be spent over a period of four years.

The plan covers a wide variety of subjects; it includes the development of attractive career-guidance material; development of careers and employment opportunities in research, education, business and industry, etc.; production of a series of educational motion pictures for different levels of learning; a program for traveling lecturers to visit colleges and high schools; establishment of pre-college science centers (summer programs) with emphasis on atmospheric problems; the writing of a series of monographs on important atmospheric subjects; and so on.

Early in 1959 the Society will present its over-all plan to certain organizations which in the past have supported imaginative enterprises in education.

Some Immediate Results. While waiting for the above-mentioned plan to be processed, steps were taken to get some action under way at once. With the help of its Committee on Education (alias UCAR) the Society obtained from the National Science Foundation a substantial grant to start the program of traveling lecturers. Under this plan, a number of research meteorologists will visit colleges and universities where there are a significant number of undergraduate students majoring in science, mathematics, or engineering. The lecturers will demonstrate the vitality of the science of meteorology, present examples of challenging problems, and make known the opportunities that exist for graduate students who enter meteorology.

At the same time, UCAR obtained a very generous grant from the Alfred P. Sloan Foundation to offer ten fellowships for the academic year 1959–60. Each recipient will receive $4,000 and may attend any qualified institution offering a graduate program in physical sciences of the atmosphere.

Outlooks. In earlier decades, the meteorologists were concerned mainly with the climates of the continents and the forecasting of weather events. With the rapid advances in the science and technology of our time, new and fascinating fields for research have been bared, and these are begging attention. In space, the problems range all the way from the grass roots and water surfaces to interplanetary space. As far as disciplines are concerned, there is hardly a field richer than meteorology. On the research side we shall need students with specialized knowledge in such subjects as mathematics, statistics, physics, astrophysics, chemistry, and

* They are: University of Arizona, University of California, The University of Chicago, Cornell University, Florida State University, The Johns Hopkins University, Massachusetts Institute of Technology, University of Michigan, New York University, Pennsylvania State University, St. Louis University, A. & M. College of Texas, University of Washington, and University of Wisconsin.

so on, and there are rich opportunities for men and women with engineering inclinations. On the applied side we may expect a rapid growth in agriculture, transportation, water resources, health, pollution and fall-out problems, business and industry, defense, and many other areas. It is foreseeable, therefore, that the students who enter a meteorological study program in 1959 will have no difficulty in finding fascinating fields of study, and that they will be in great demand when they, in due course, emerge with a degree.

Circulation (*Continued from page 12*)

regime, with an extremely warm ridge in the West and a cool trough in the East. During the second half, on the other hand, a new trough developed in the Southwest and deepened in the center of the country. New record low temperatures were established at many places in the western half of the nation as a surge of cold air plunged southward. At the same time the Southeast basked in a late-season heat wave as tropical air was carried northward ahead of the trough. The contrast between these air masses generated a series of intense storms which were accompanied by widespread precipitation. Consequently November was considerably wetter than October in much of the country, and over twice the normal amount fell in northern portions of the Great Plains and Rocky Mountain areas. At Glasgow, Montana, this precipitation ended 14 consecutive months with subnormal amounts.

During December a strong ridge again became established over the western United States, accompanied by a deep trough in the East and a large blocking high north of Alaska, a pattern reminiscent of February (figure 2). The resulting strong northwesterly flow was responsible for repeated outbreaks of cold arctic air east of the continental divide, but the West remained warm under the sheltering influence of the mountain barrier and the ridge aloft.

THE YEAR AS A WHOLE

The prevailing circulation pattern of the year 1958 over the United States consisted of a ridge with above normal 700 mb heights in the West and a trough with below normal heights in the East. This dominant pattern was well established during January and February (figure 2) and recurred with minor variations in May (figure 4), June, August, October (figure 8), and December. It resulted in one of the driest years on record in parts of the northern Plains, Midwest, and Southeast, and one of the wettest in New England and Texas.

One of the consequences of the recurring ridge in the West was abnormal warmth in southerly flow along the Pacific coast. This effect was enhanced by the fact that sea surface temperatures along the west coast have also been above normal. The year 1958 was one of the warmest on record on both a monthly and annual basis at numerous cities in California. At Los Angeles and San Diego temperatures averaged above normal during every month of the year except March. By way of contrast, at Parkersburg, West Virginia, in the quasi-permanent eastern trough, temperatures averaged below normal during 10 months of 1958, while Evansville, Indiana, reported that its mean temperature for 1958 was the coldest of any year on record.

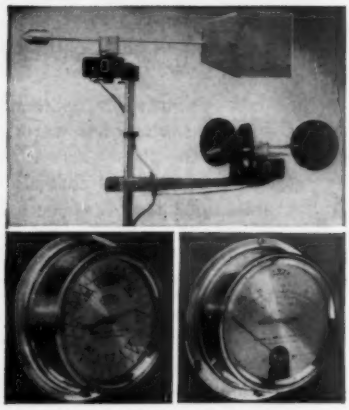
Snow (*Continued from page 27*)

lumbia. During this period the California mountains were relatively snowless, but with a later shift of the storm track southward in February and March the Sierras and adjoining ranges had impressive snow totals as the winter season neared an end.

Paradise Ranger Station in Washington on the slopes of Mt. Rainier at 5,550′ elevation had 167.5″ in December and 121″ in January, the only months in the 1957–58 season exceeding 100″. The total fall there to 31 May amounted to 602″. The snow this season was mainly confined to higher elevations as the Seattle-Tacoma area had only traces.

In Oregon, as usual, Crater Lake returned the greatest measurements. The season total there at 6,475′ was 572″; again December and January were the only months which topped the century figure. In the Portland region only traces were noticed throughout the entire winter.

Fears had begun to be expressed in midwinter about the available snow pack on the California mountains, but a great burst of cyclonic activity over the state in late February and March wiped out all such misgivings about the water supply. At higher elevations generally 100″ and more fell in both February and March.



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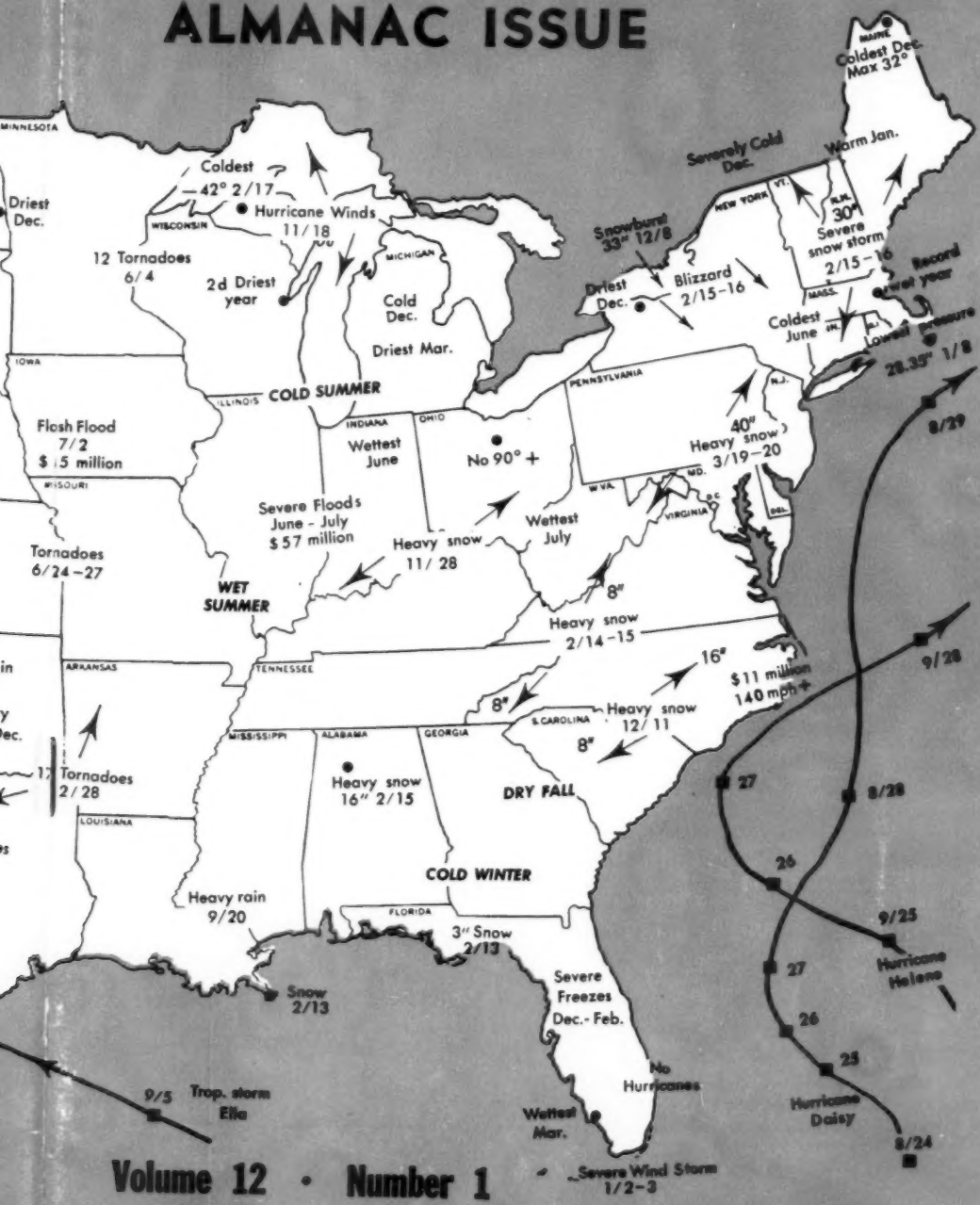

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